Software Intelligence with

Codeface

Understanding the Linux Ecosystem

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Overview

What's Open Source Software about?

- Publishing code
- Building communities → *Network effects!*

So there are network effects…BUT:

- Different types?
- Good and bad approaches?
- Impact of technology?
- Better software?

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Overview

What's Open Source Software about?

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Overview II

Why?

- Learn about *embedded software ecosystem*
- Find proper *involvement*
- Project *controlling*
- Learn from masters!

The two problems of software development

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Problem 1: It's about Technology

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Problem 2: It's about People

Project: Software Intelligence

Pharmaceuticals

- ✓ A-priori understanding
- ✓ Tests & statistics

Image source: `fraxinusit.com`

Project: Software Intelligence

Pharmaceuticals

- ✓ A-priori understanding
- ✓ Tests & statistics

Software

- ✗ Comparative experiments
- ✗ Quantify people and behaviour
- ✗ Personal experience limited

Image source: `fraxinusit.com`

Introducing Codeface

Codeface

Codeface: Two Aspects

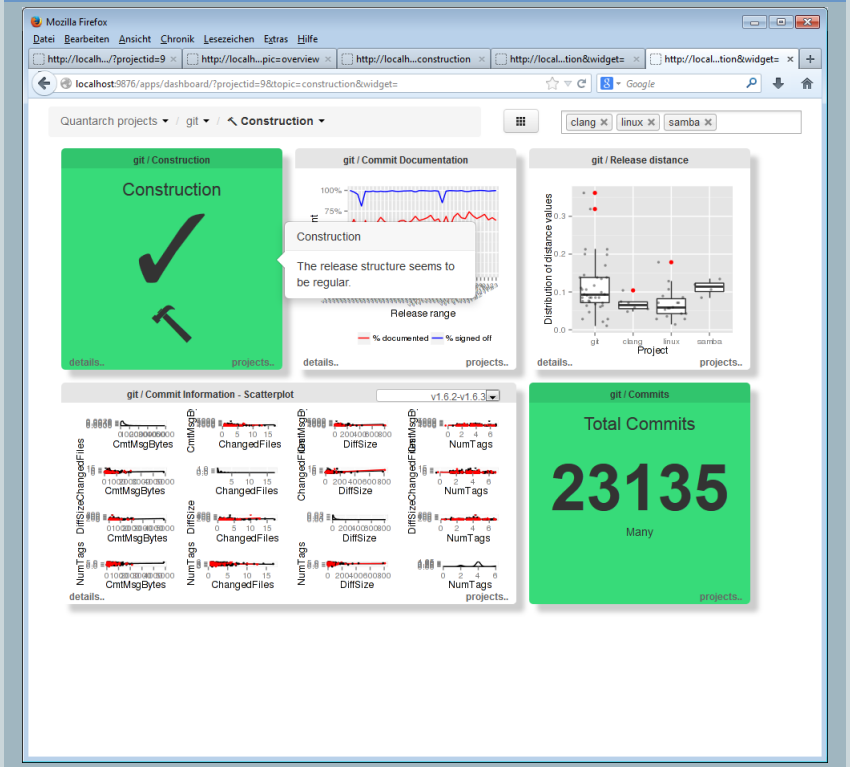
(Fundamental) Research

$$P_{R_i}(k) = P_G(k) \; \forall R_i \in \mathcal{R}$$

$$P_{\mathcal{R}}(Q) = \frac{|\{i \in [1, |\mathcal{R}|] \mid q_{R_i}(\mathcal{C}) = Q\}|}{|\mathcal{R}|}$$

$$H_0 : P_{\mathcal{R}}(Q = q_G(\mathcal{C})) > \epsilon$$

Practical Software



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Project Goals

Learn from SW Devel Data

- Objective properties of successful projects
- Understand network effects
- Quantify social factors
- Mine large bodies of software (calibration: open source)

Find *Actionable* Insights

- Find most efficient approaches *for a given scenario*
- Assess ongoing development
- Make informed choices

-ENOINTENTION

Don't impose mandatory interpretations!

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Data Sources

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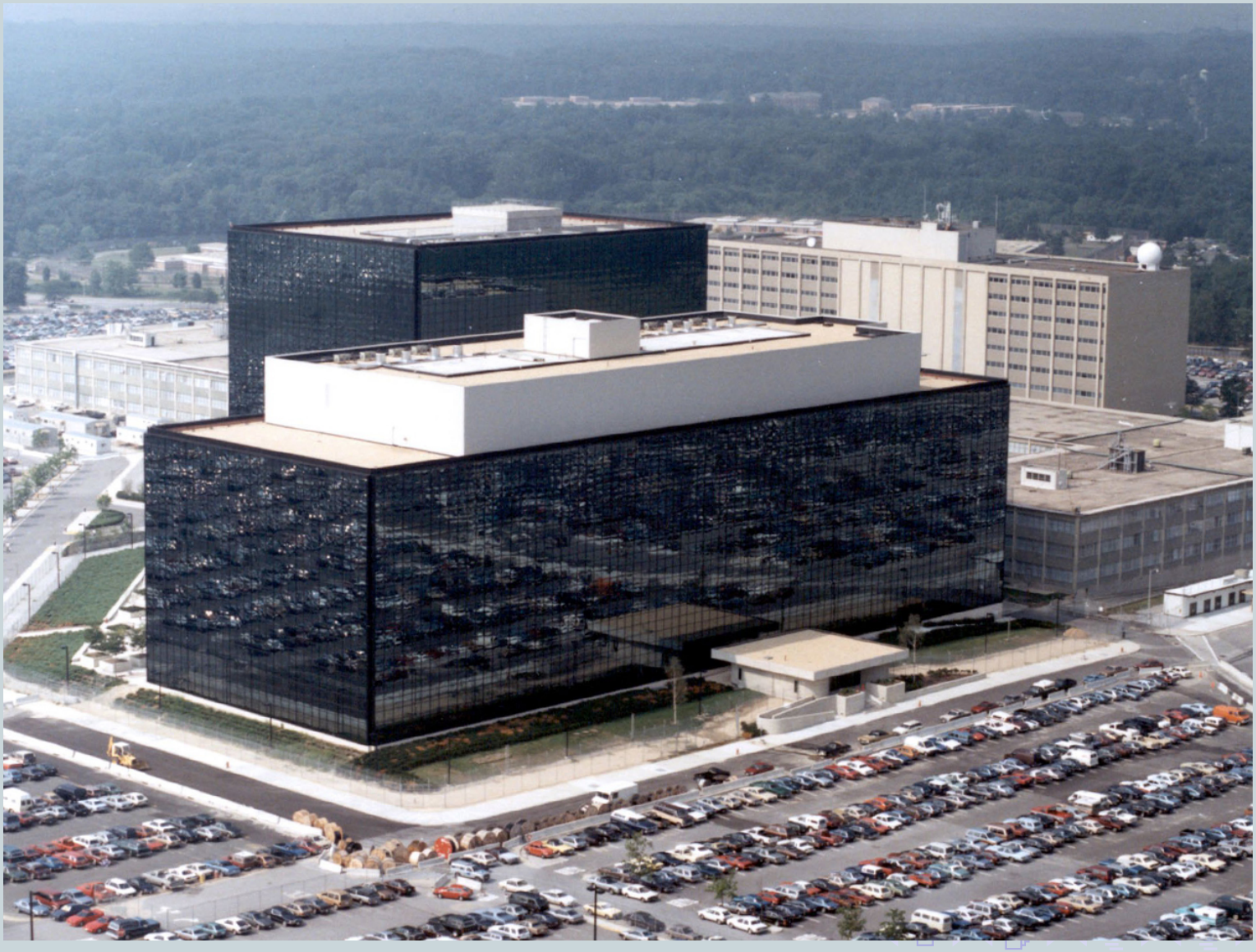
Data Sources



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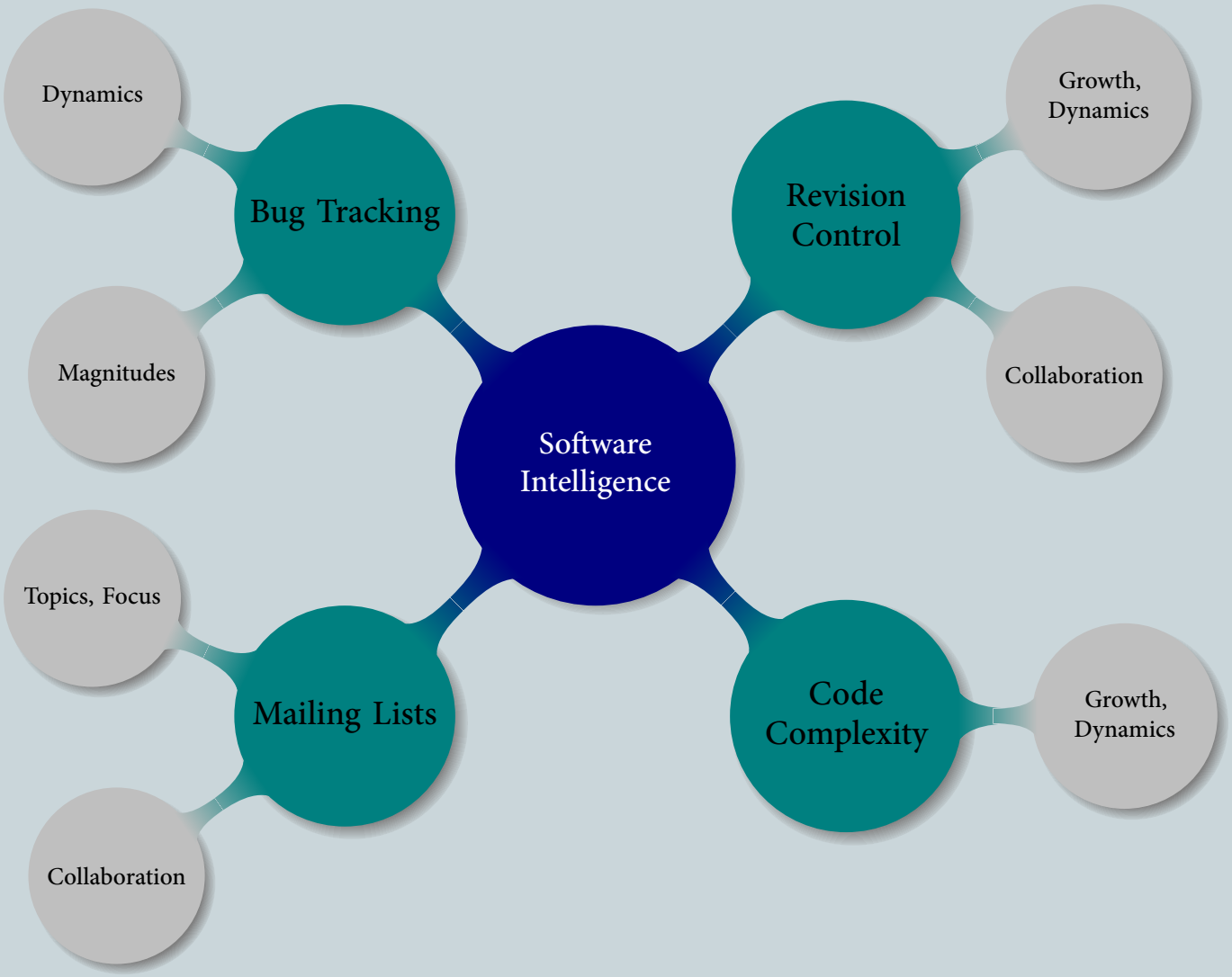
Data Sources



Examples

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Example – Time Series

Example – Time Series

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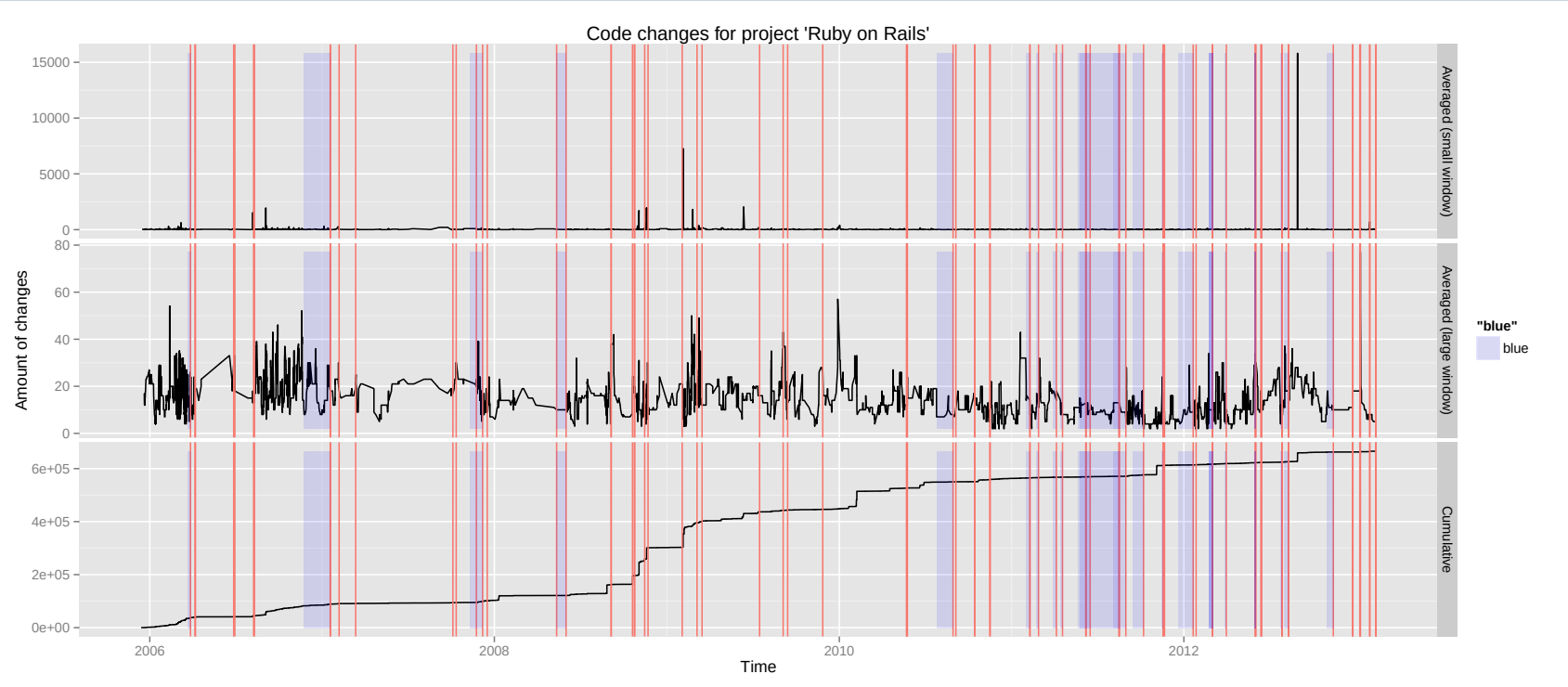
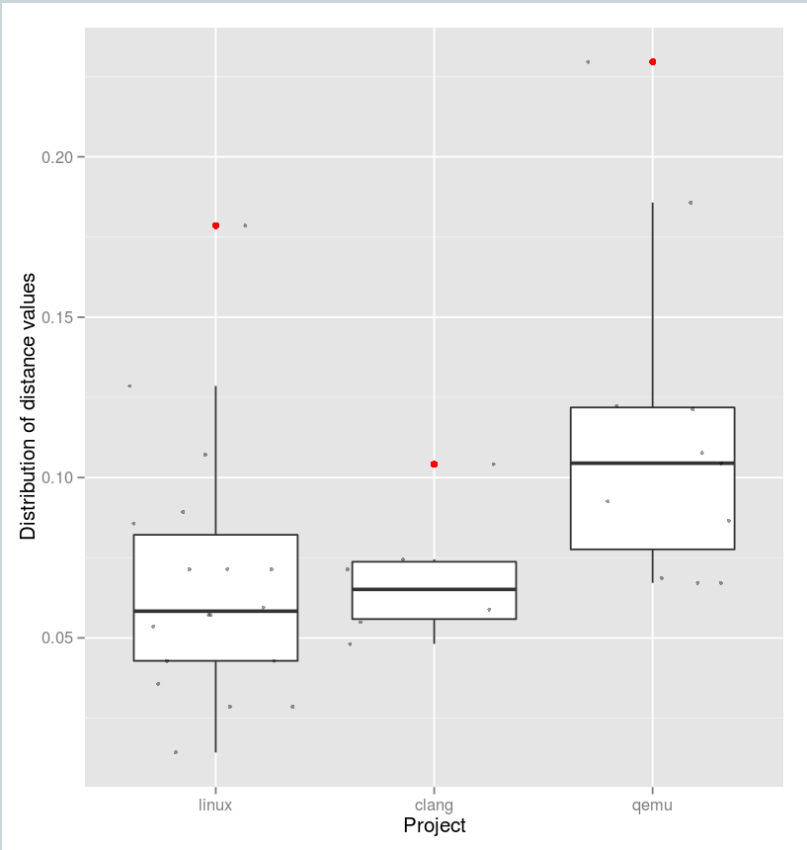
Example – Time Series



Time Series II

Interpretation

- No objectively „optimal“ approach
- Self-Consistency matters!



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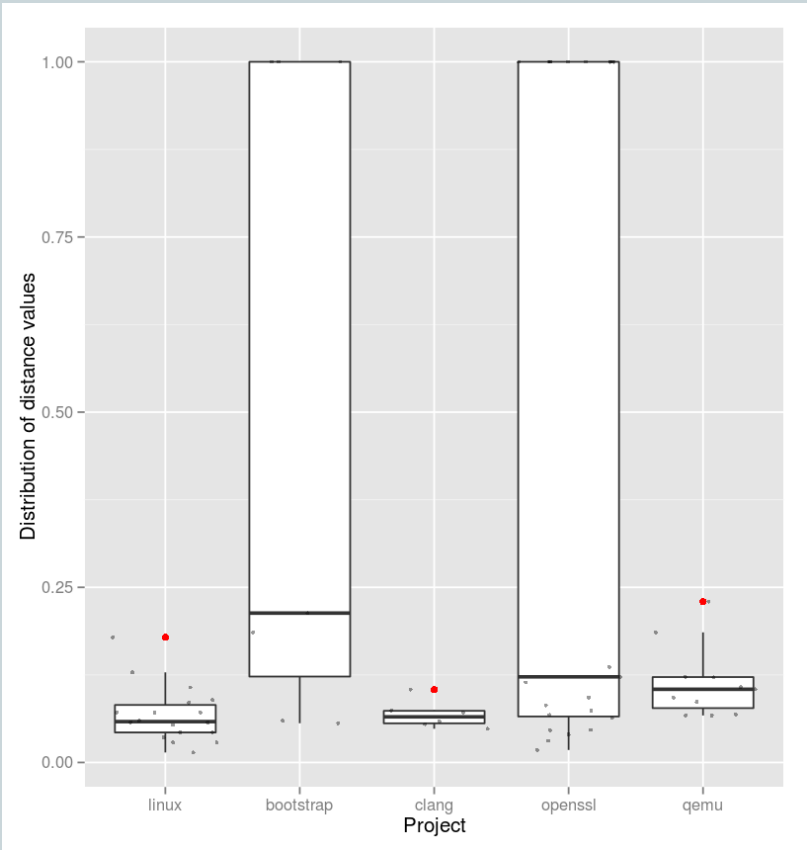

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Example – Communication: Paths & Topics

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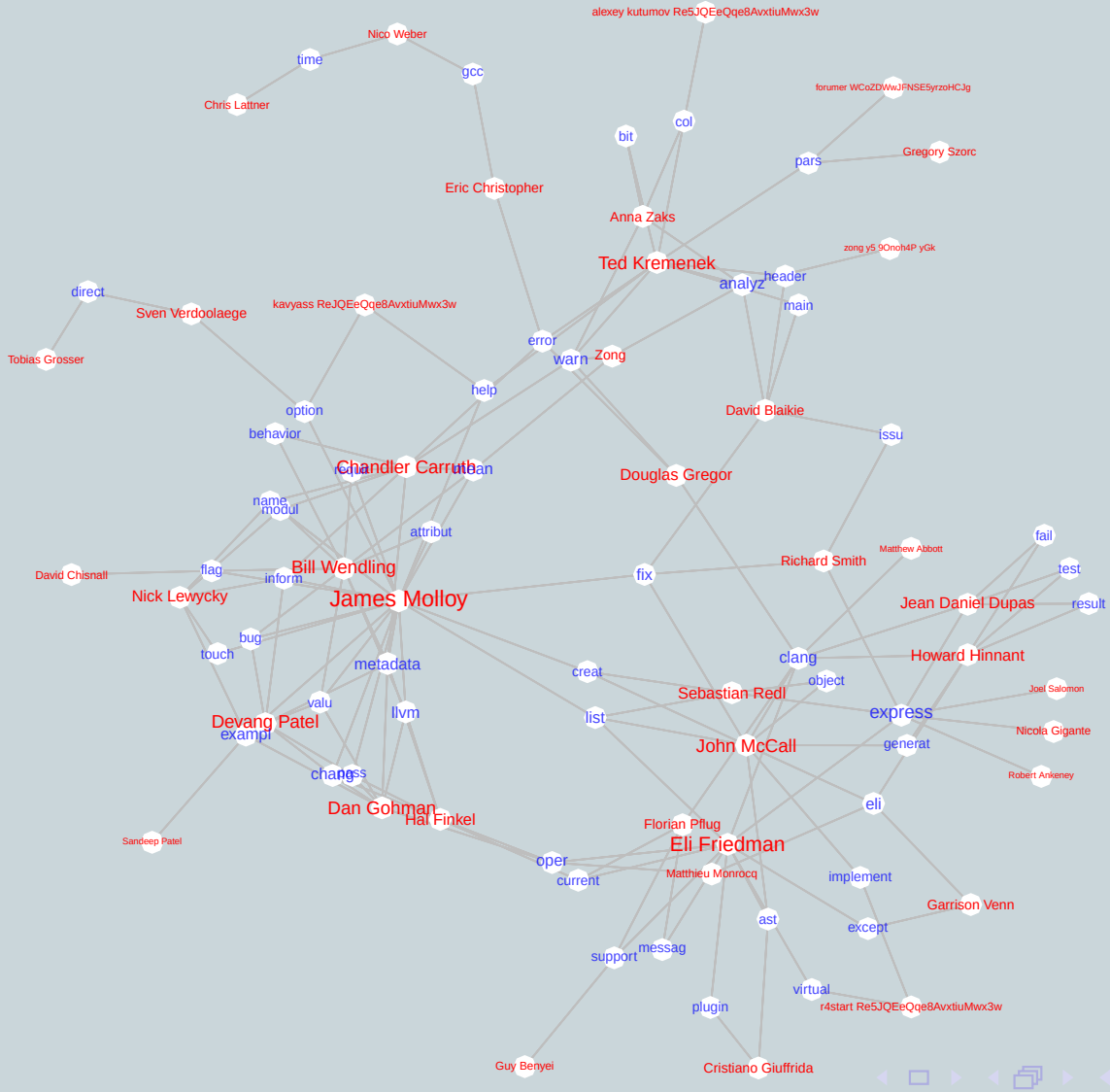
Example – Communication: Paths & Topics



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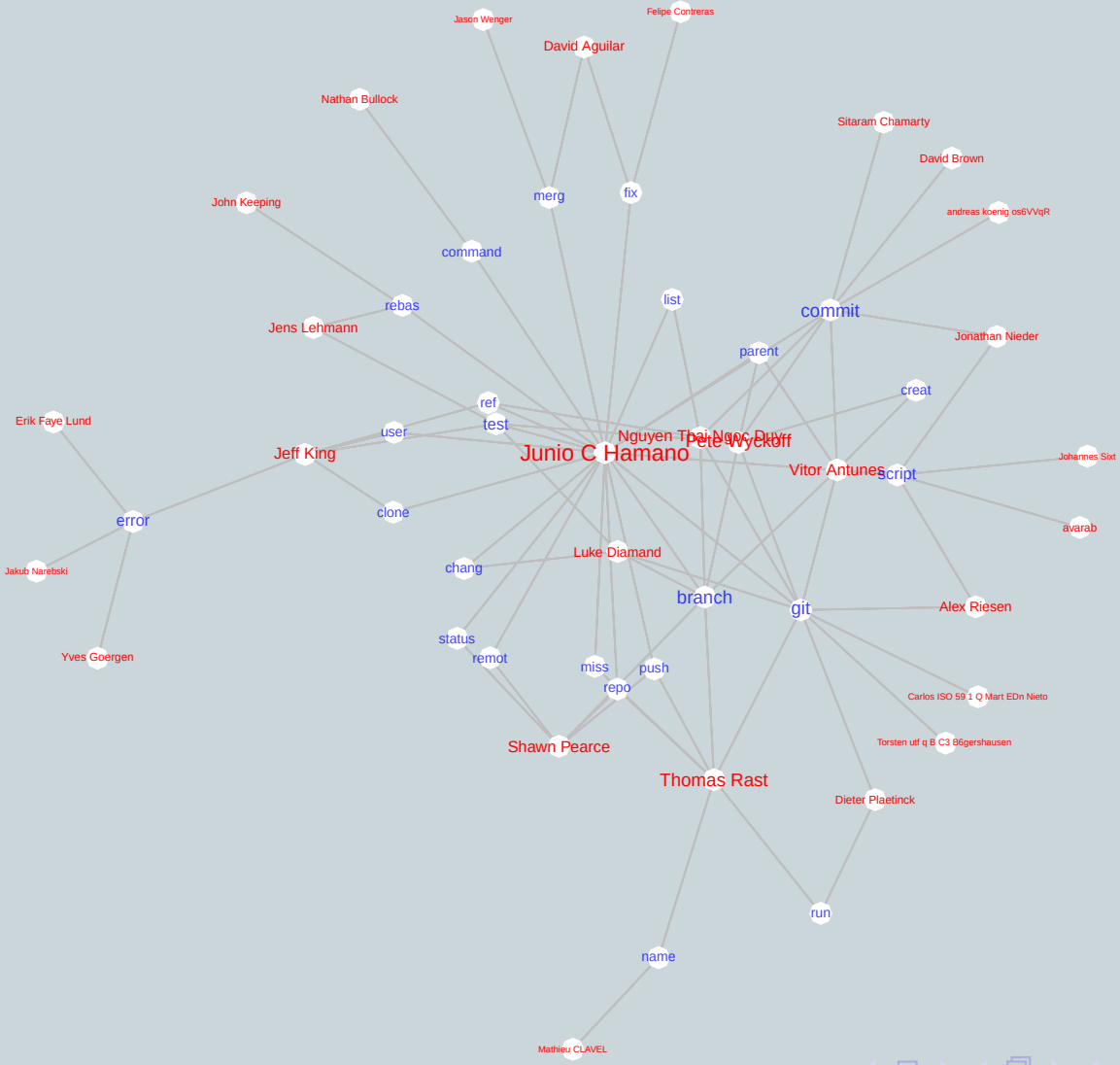

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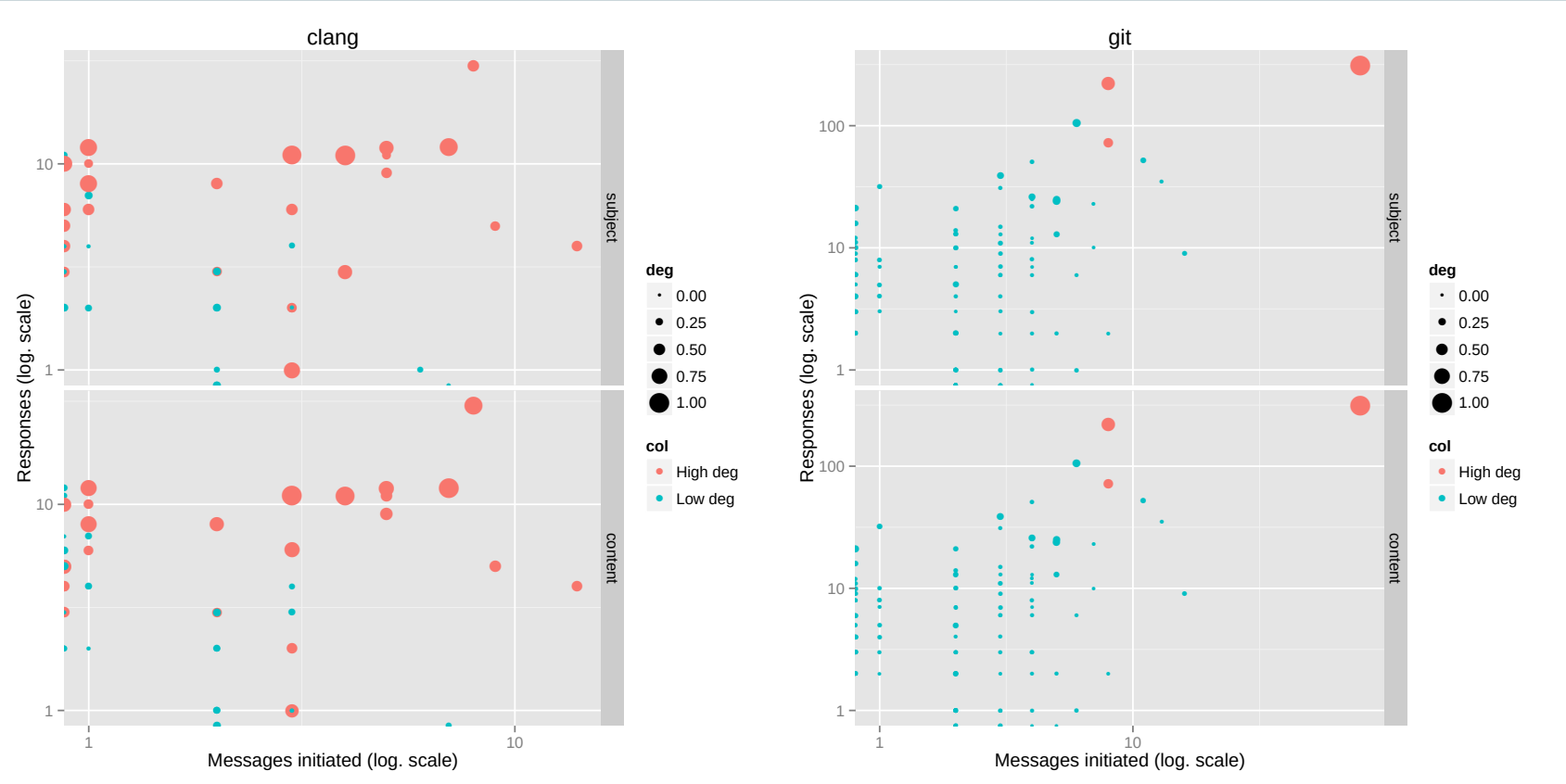
Communication Paths & Topics

It's not the content…

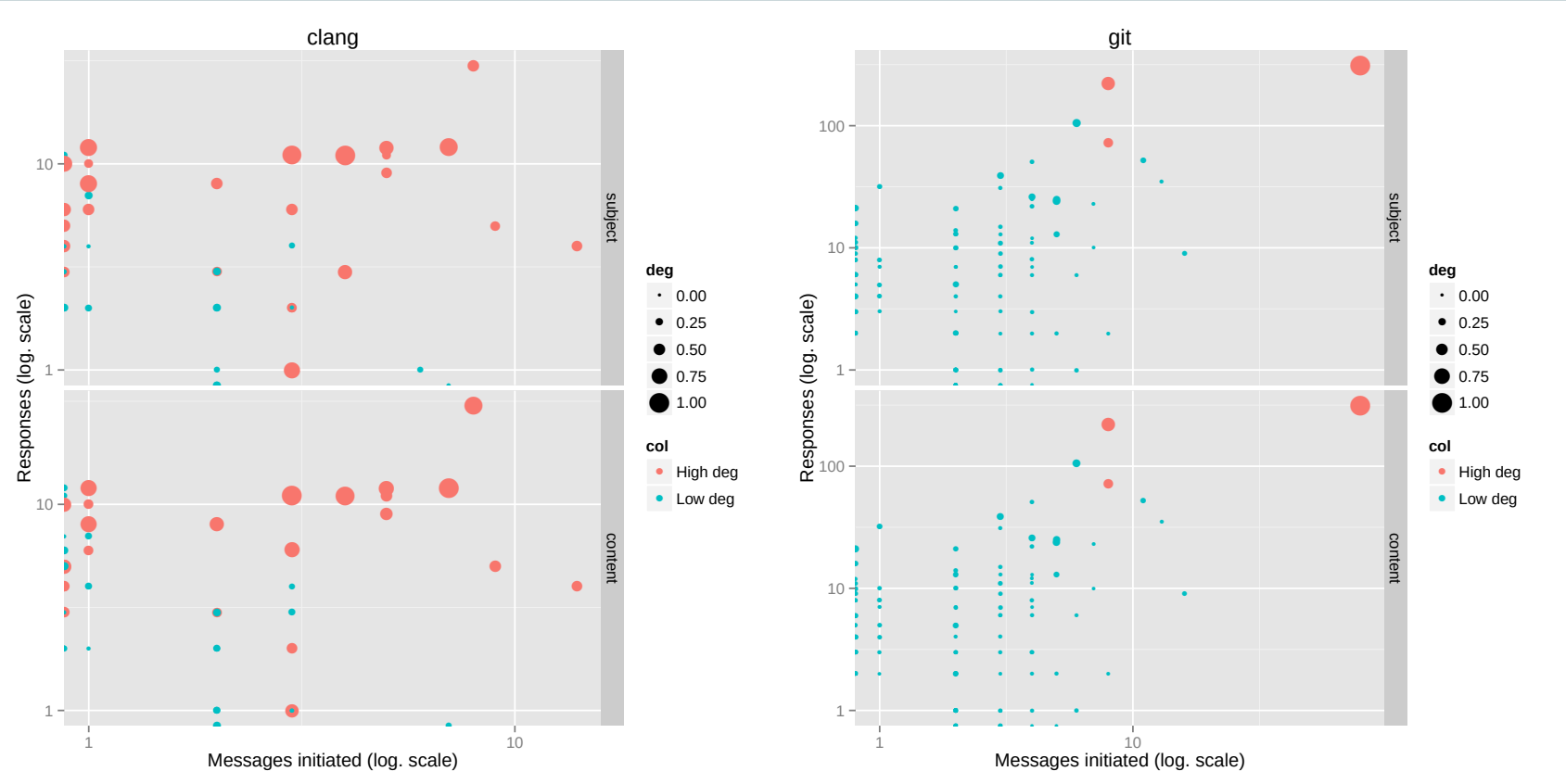
- Topics: No surprises
- Hard to evaluate by machines
- *But:* Overall picture meaningful

Examples – Communication Paths & Topics



Content does not matter—subjects suffice!

Examples – Communication Paths & Topics



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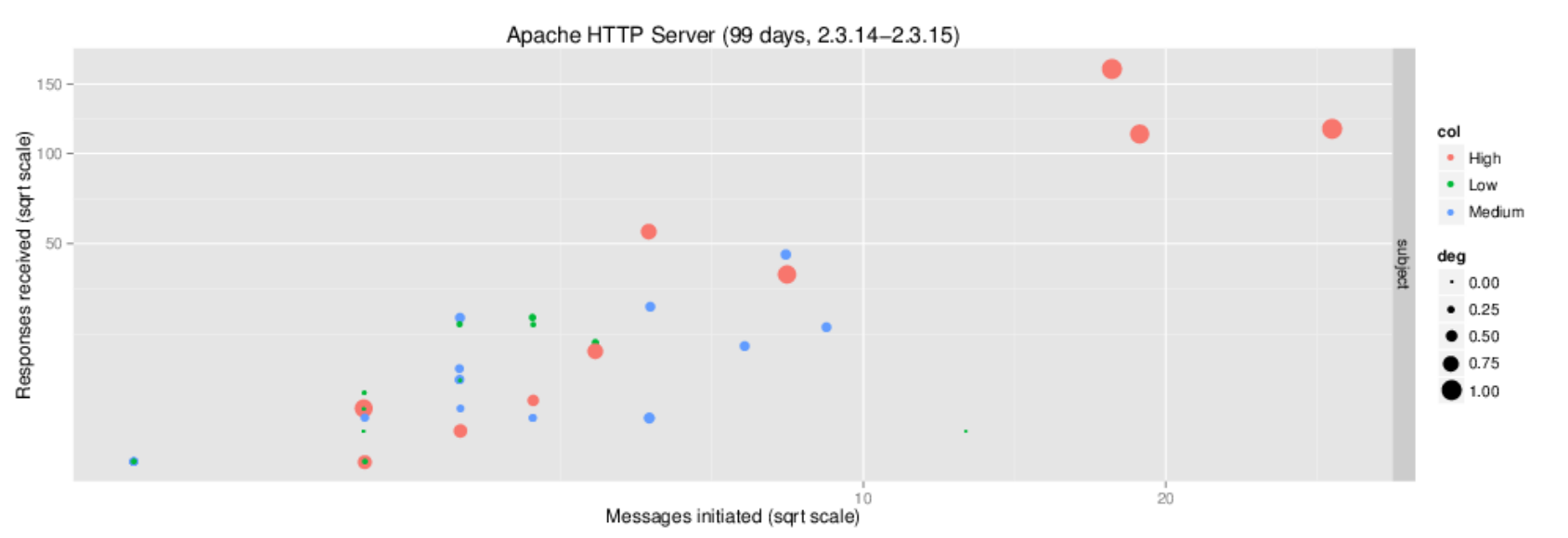
Communication Paths & Topics II



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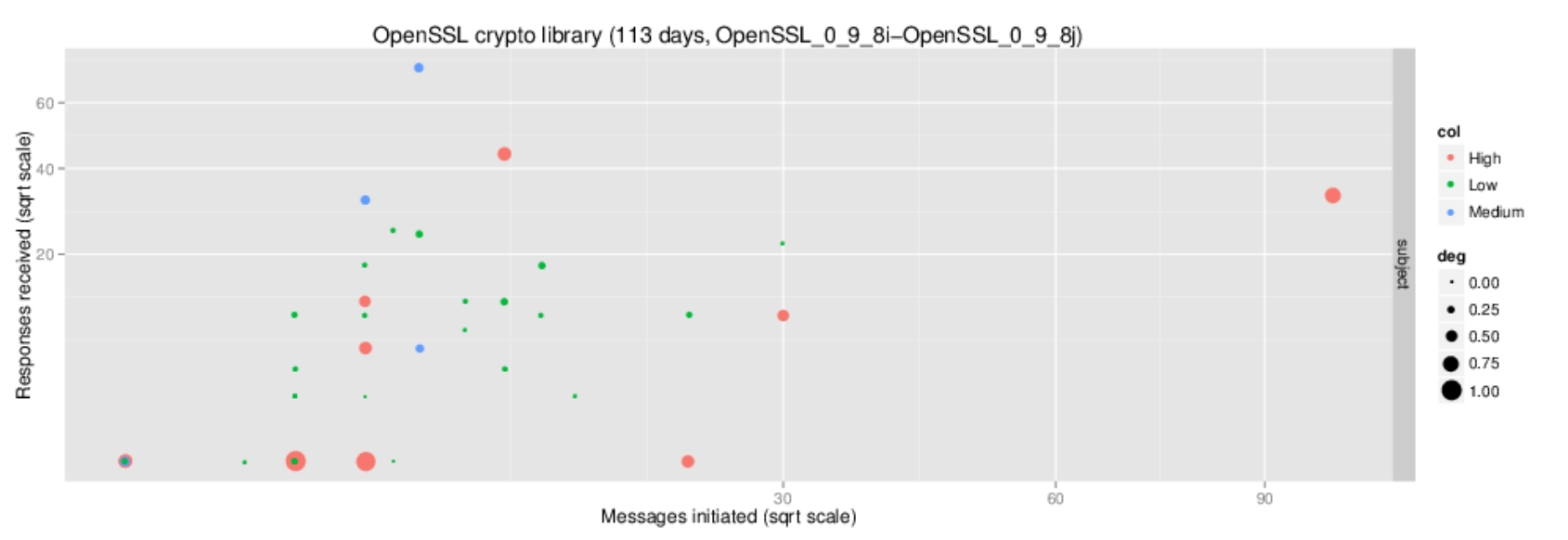
Communication Paths & Topics II



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Examples – Cooperation and Teams

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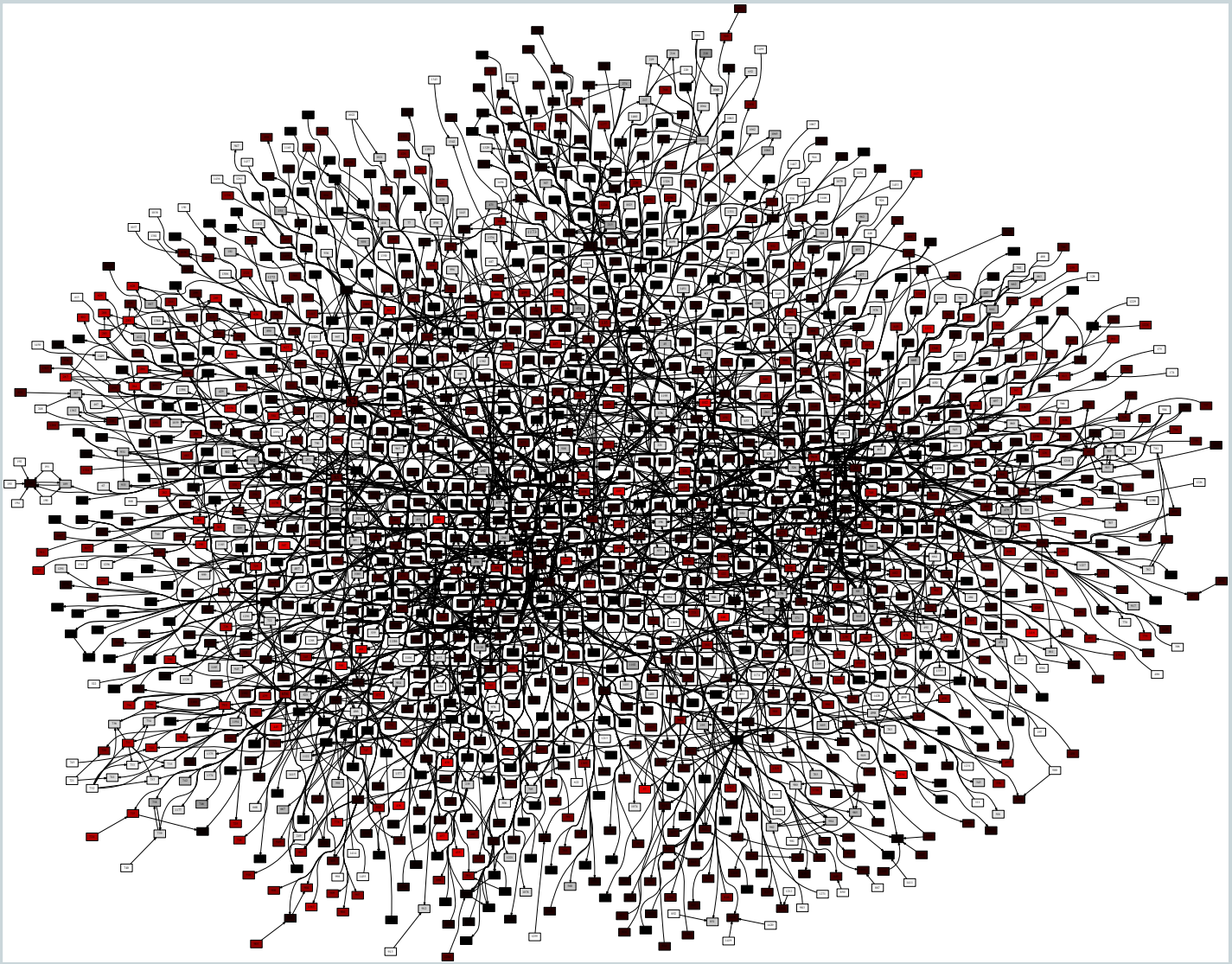

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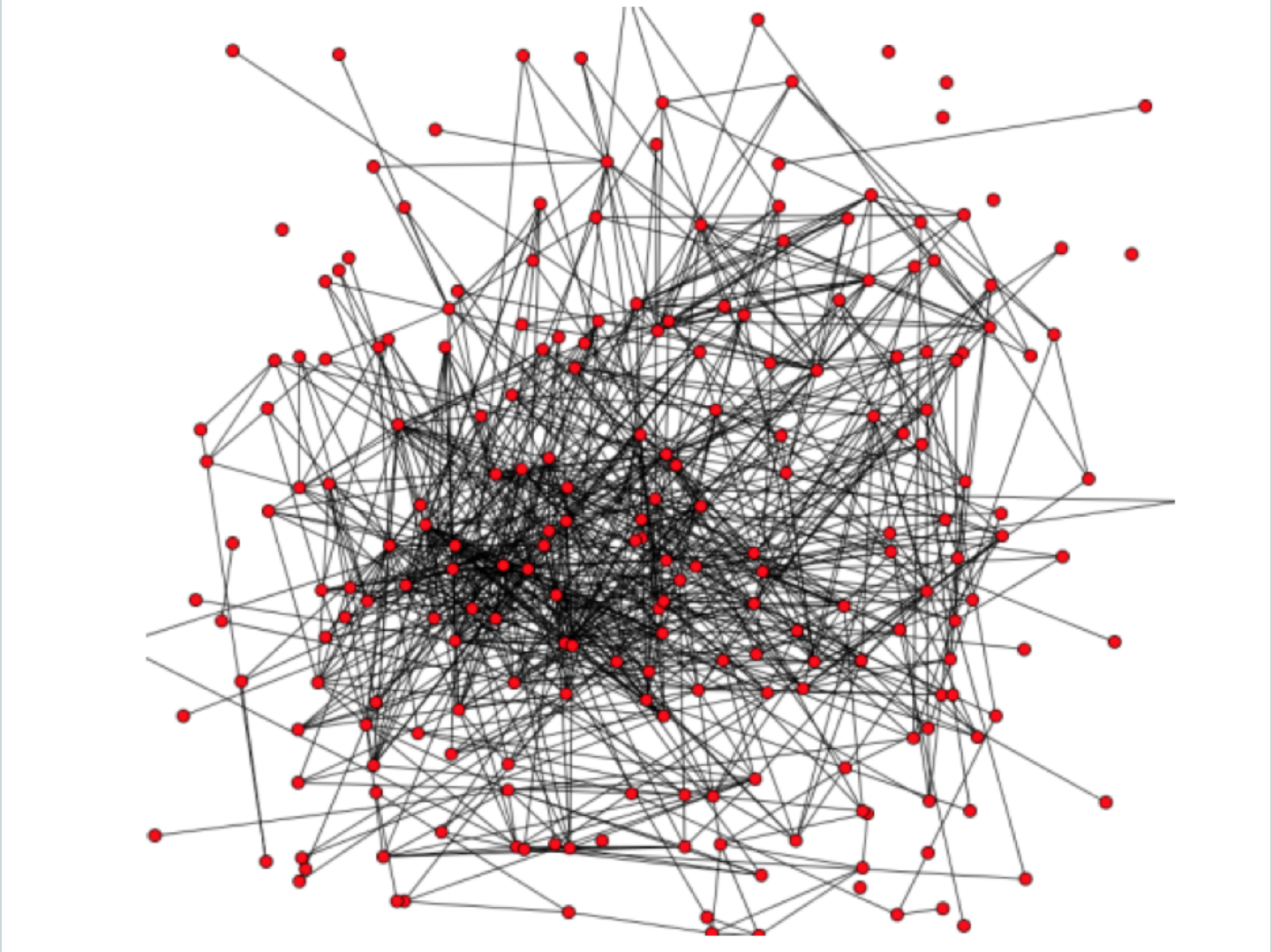
Examples – Cooperation and Teams



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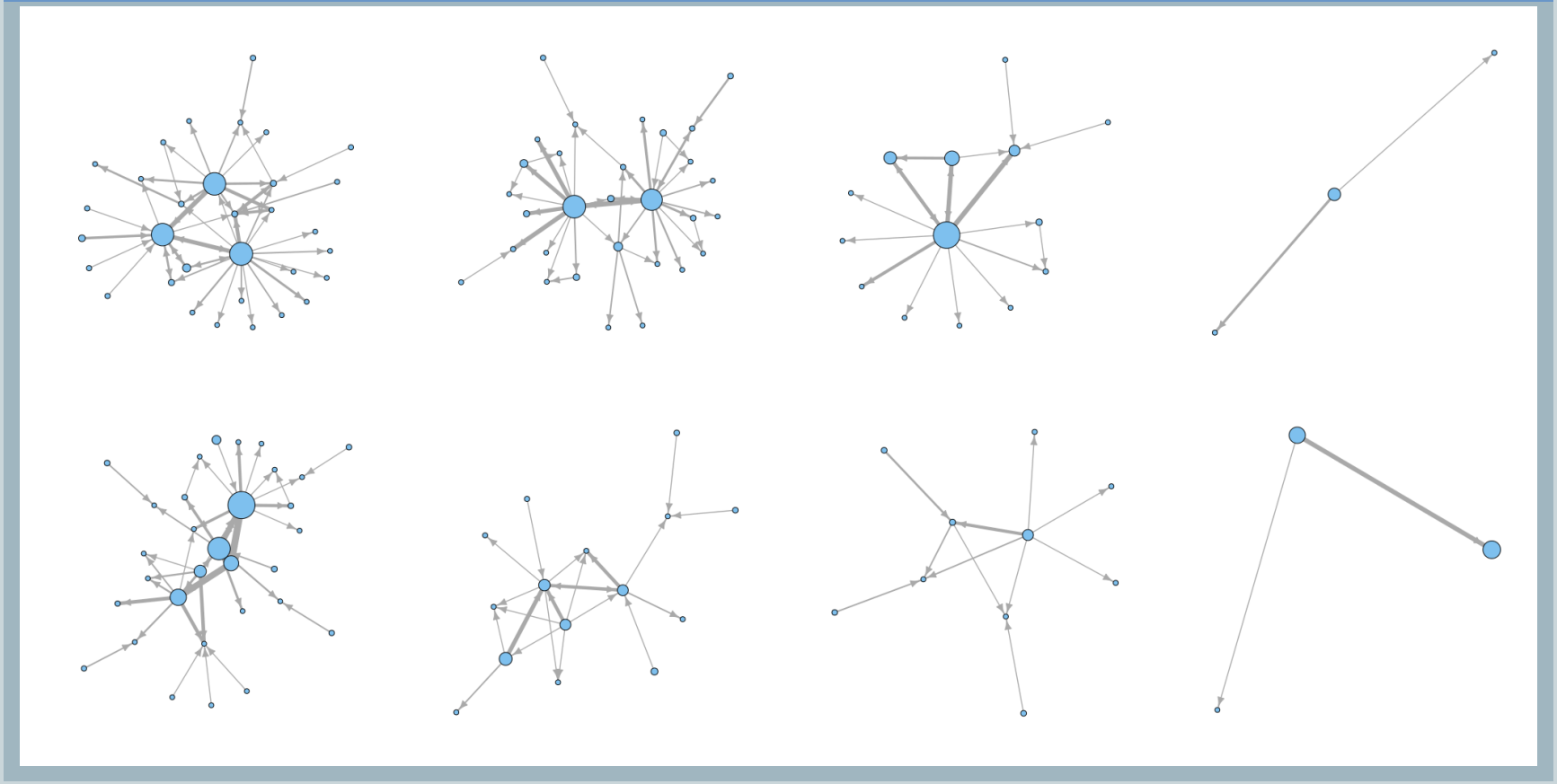
Cooperation I

QEMU: Current State



- Influence of individual contributors
- Group structure

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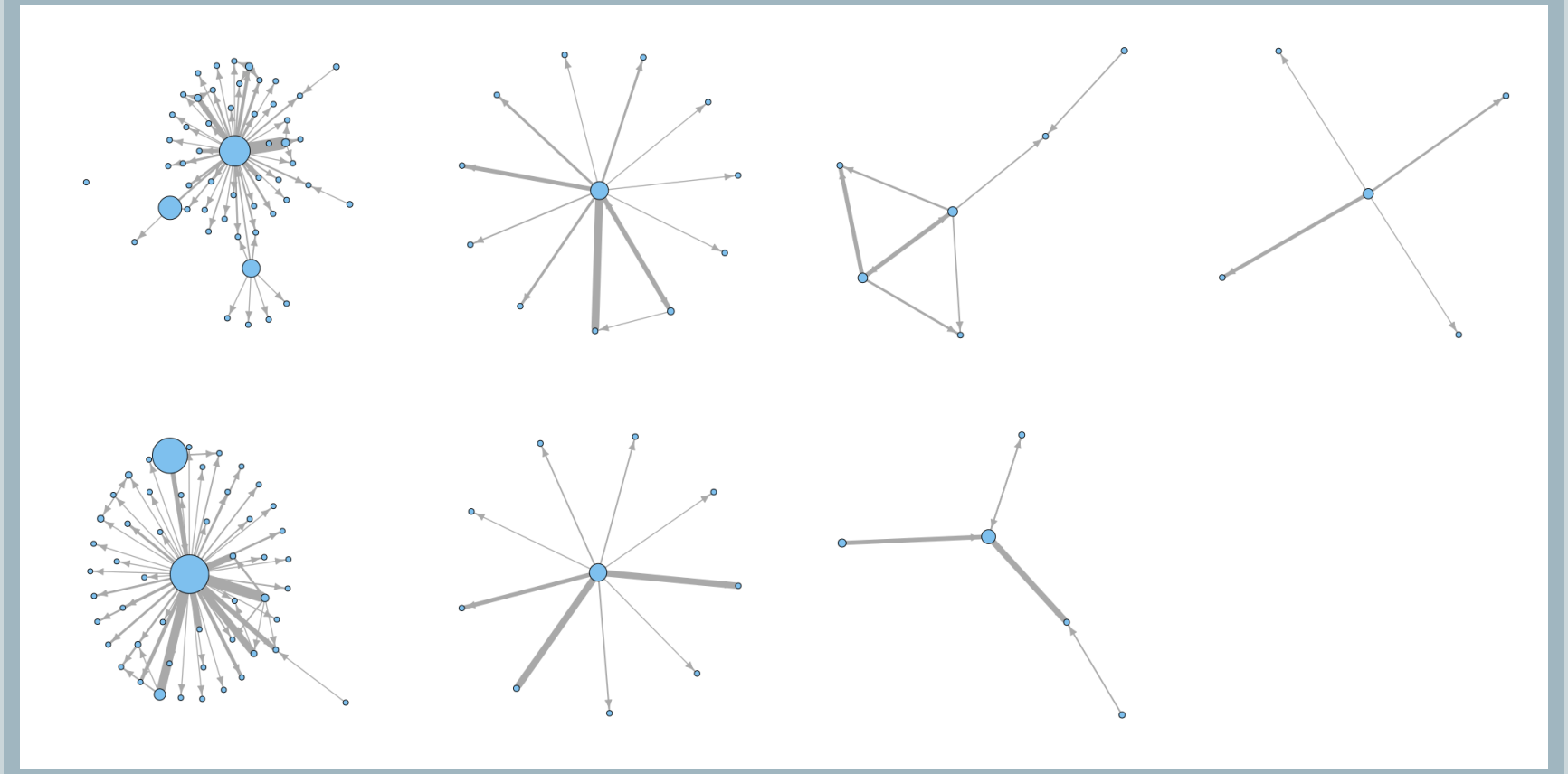
Cooperation I

QEMU: Early Days



- Influence of individual contributors
- Group structure

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Cooperation II

How to…

- Construct network?
- Determine contributor centrality?
- Identify (meaningful) subgroups?

Cooperation III

Network construction

- Tagging (“Signed-off-by”)
- Committer-Author
- Overlapping contributions

Contributor Centrality

Google’s Page Rank

Community Decomposition

- Spin Glass approach

Image source: `cdn.oliveandcocoa.com/`

Cooperation III

Network construction

- Tagging (“Signed-off-by”)
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Contributor Centrality

Google’s Page Rank

Community Decomposition

- Spin Glass approach
- Vertices (developers) have spin state $\in [0, c]$
- Edges (connections): Preferences to spin states
- Approximate lowest energy state
- Multi-Method support: OSLOM, Random Walks

Image source: `cdn.oliveandcocoa.com/`

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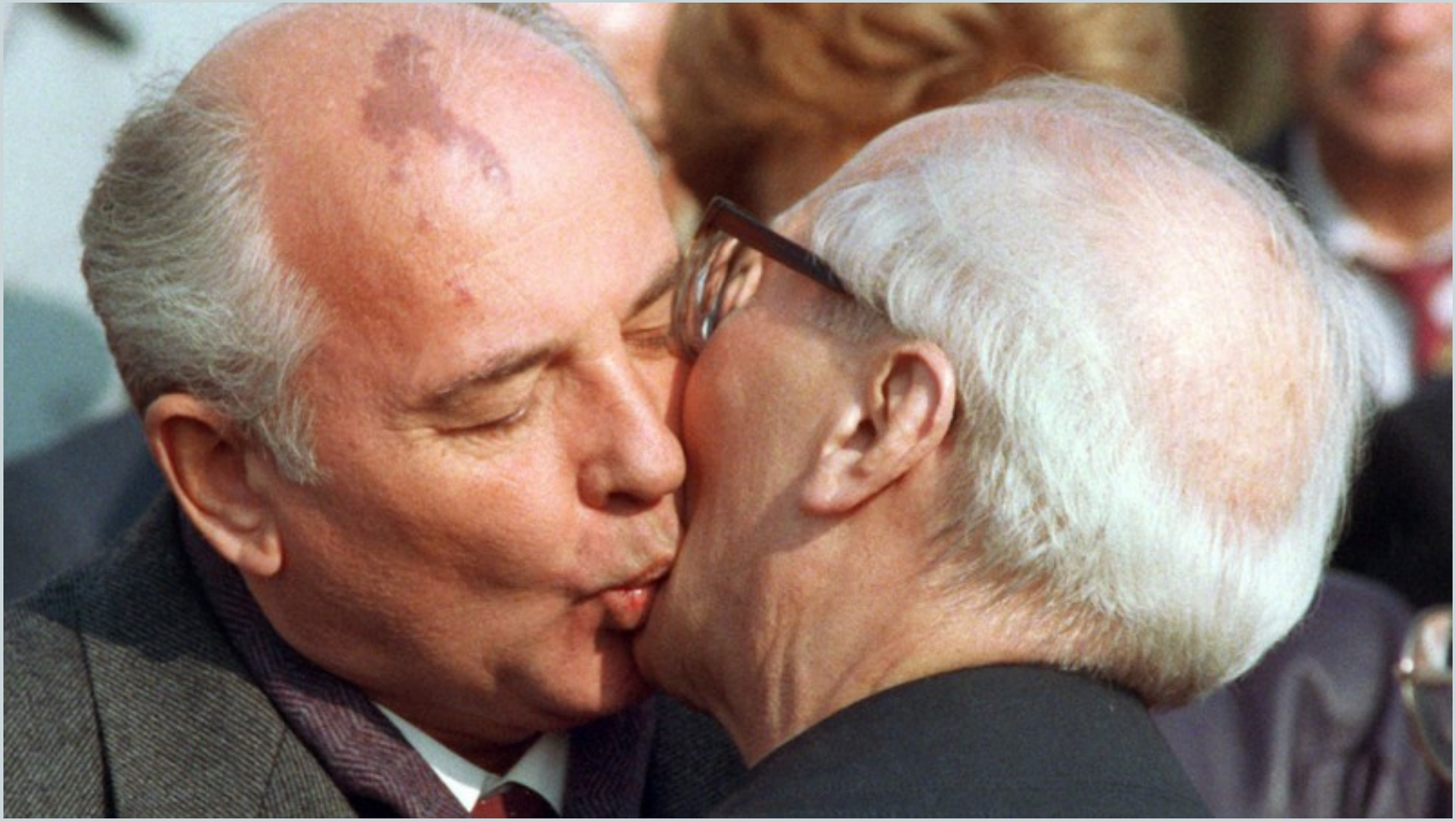
It's about People, part 2: Trust



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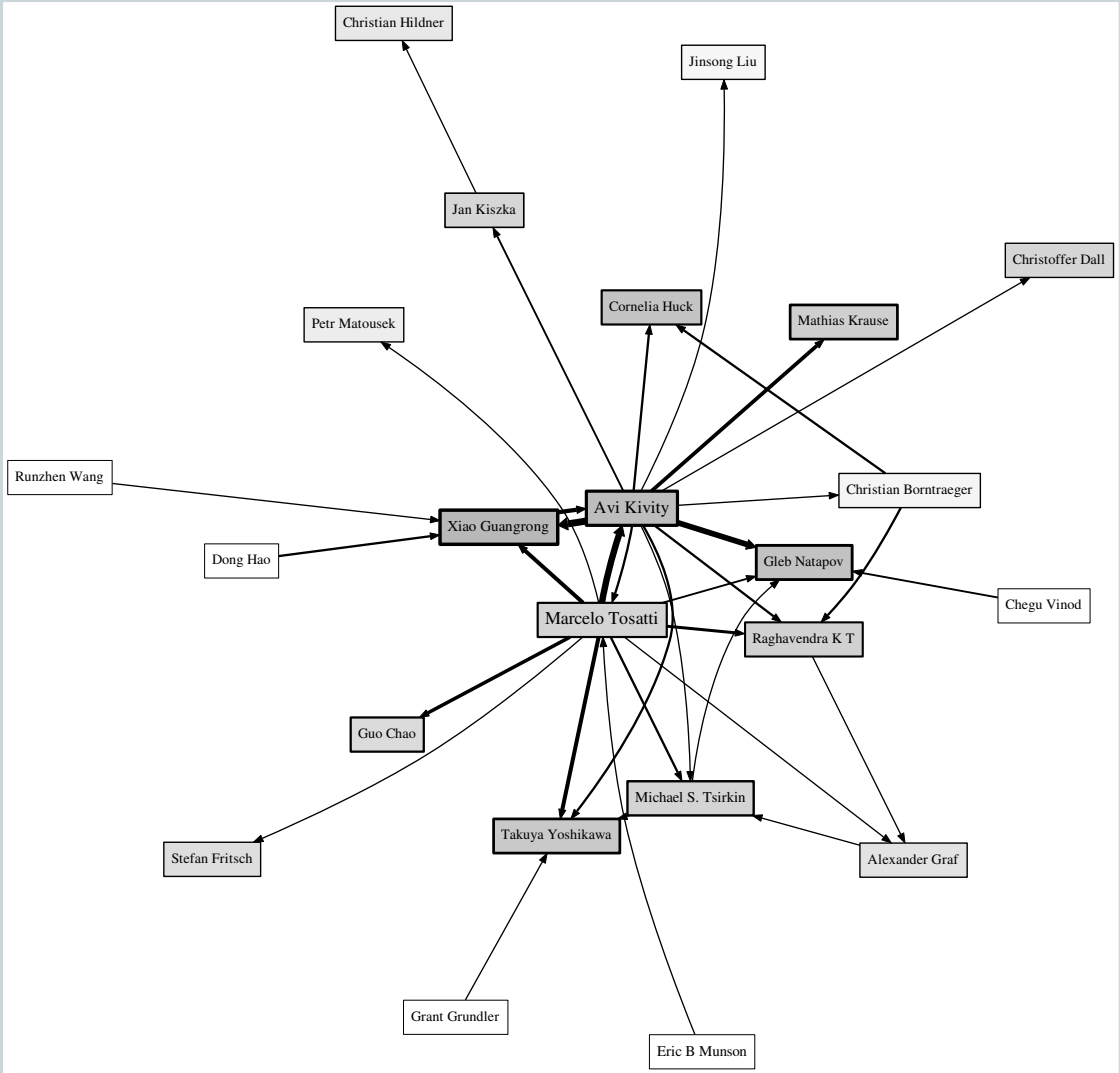
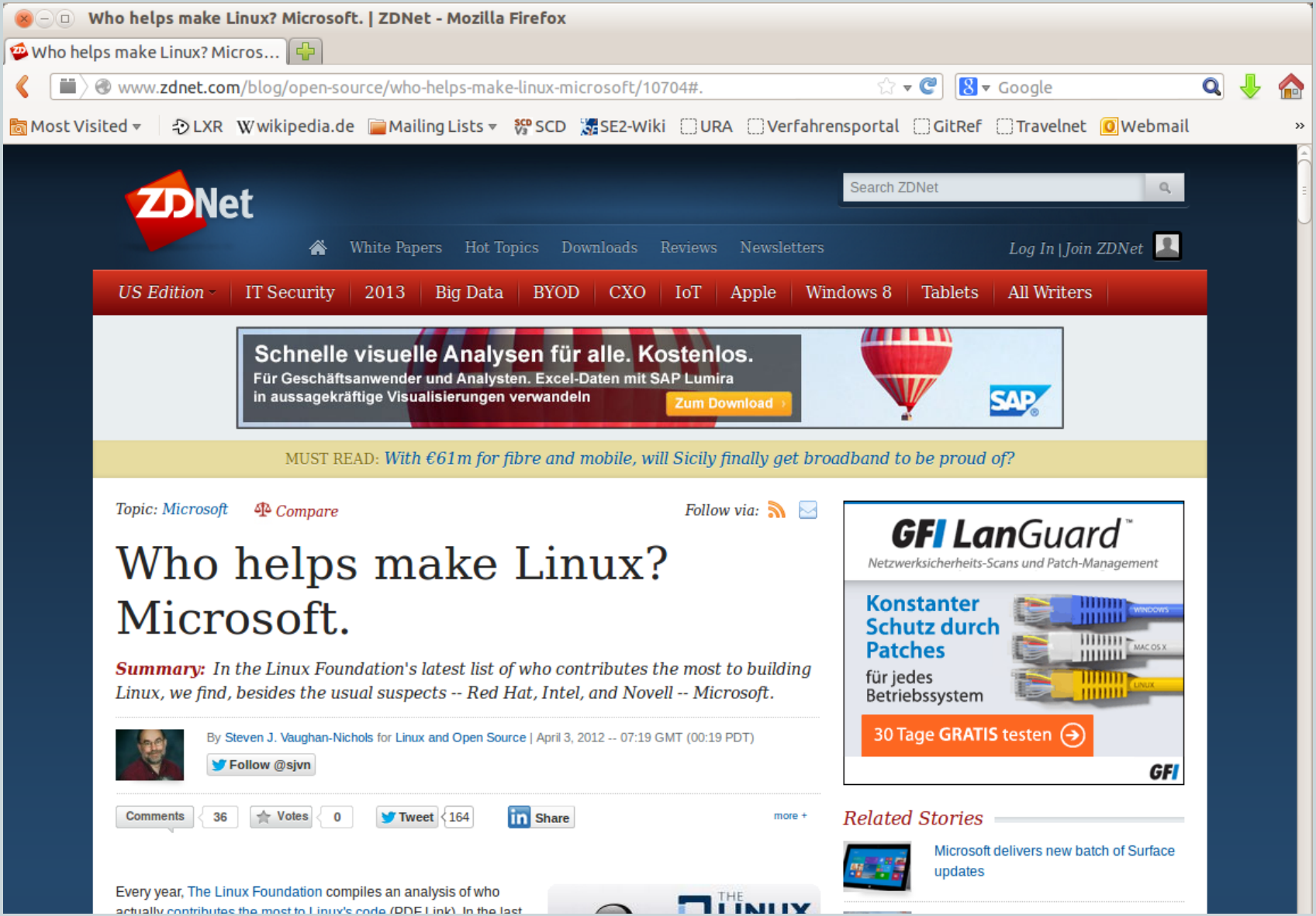
Community Validation: Expert Knowledge



Microsoft is taking over the Linux kernel!



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Microsoft is taking over the Linux kernel!

Top Linux 3.0 Contributors (# Commits)

K. Y. Srinivasan	343	3.8%
David S. Miller	176	2.0%
Dan Williams	149	1.7%
Jonathan Cameron	119	1.3%
Takashi Iwai	108	1.2%
Mark Brown	91	1.0%

- Surely people $\neq f(x_1, x_2, \ldots, x_n)$
- Maybe persons $\approx f(x_1, x_2, \ldots, x_n | \text{large context})$

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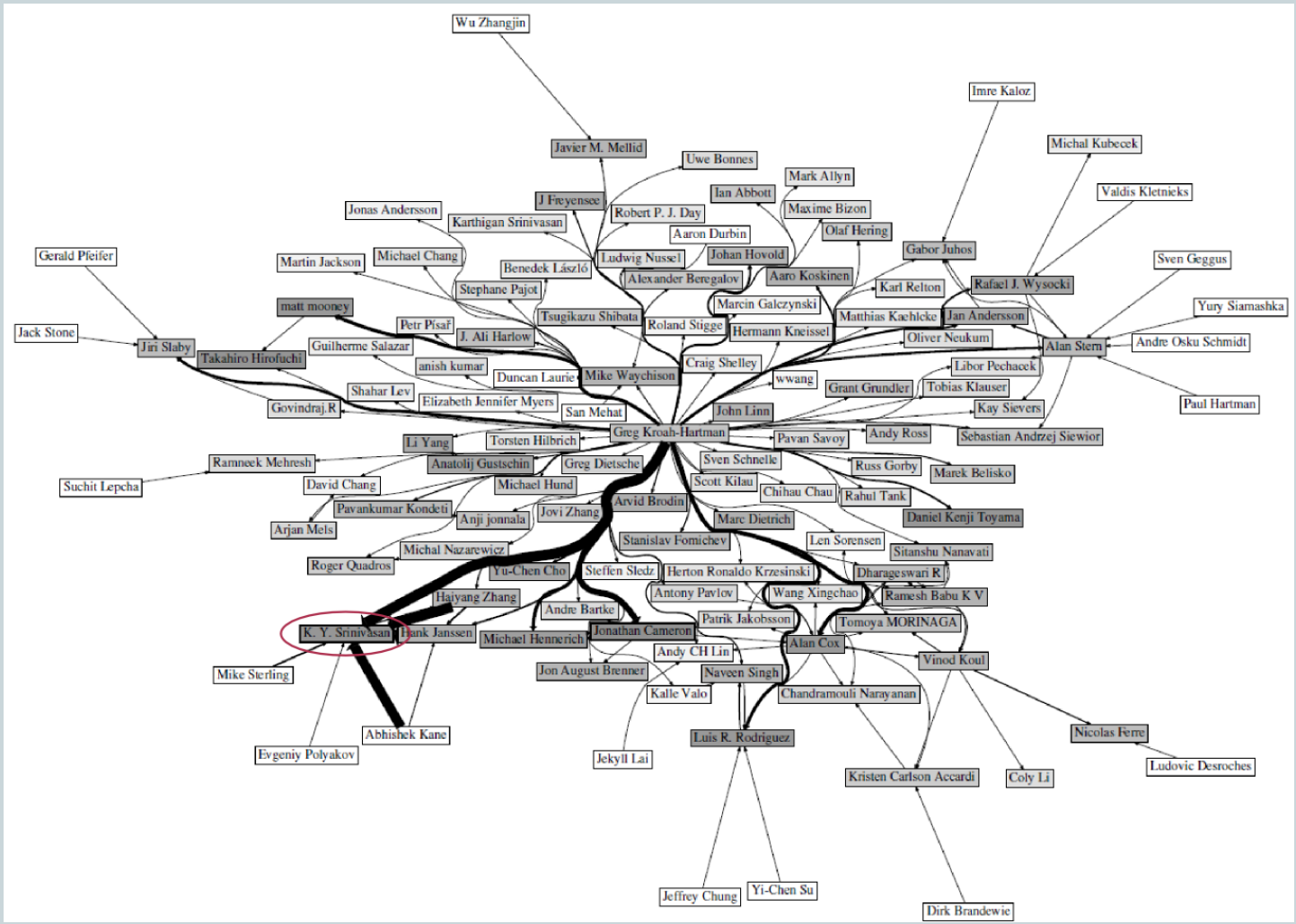
Communities vs. Numbers



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Let's go Quantitative

Nonsense

- Black xor White
- Optimal approach
- Counting apples and peas per developer per minute times square foot

Sense

- How does $\langle A \rangle$ compare to $\langle B \rangle$?
- Self-consistency
- Likelihood of result compared to random approach

Community Decomposition and Quality Estimation I

Quality Estimation

- Meaningful community structures vs. random properties
- Randomise clusters
  - Rewire edges
  - Keep properties (e.g., “amount” of participation)
- H_0: Clustering stems from unorganised, random process.
- Reject $\rightarrow$ Decomposition makes sense

Alternative Approach

Ken Schwaber says: A team has seven people (plus or minus two). Full stop!

Community Decomposition and Quality Estimation I

So let's study the Maths!

Conductance $\phi \in [0\,,\,1]$ of a community C that is a sub-graph of a larger collaboration graph G is defined as

$$\phi_G(C) := \frac{|(C, G\ C)|}{\{(C), (G\ C)\}}\,, \tag{1}$$

Identify a set of communities $\mathcal{C} = \{C_1\,,\,C_2\,,\,\ldots\,,\,C_i\}$, $C_i \subseteq G$. Conductance over all communities is given by $q_G(\mathcal{C}) = \sum_{C\in\mathcal{C}} \phi_G(C)/|\mathcal{C}|$. Rewire an edge pair $(u\,,\,v)$ and $(s\,,\,t)$ is rewired to $(u\,,\,t)$ and $(s\,,\,v)$, maintaining the number of edges) but destroying the preferential attachement. Repeat to generate a set $\mathcal{R} = \{R_1\,,\,R_2\,,\,\ldots\,,\,R_m\}$ of randomized graphs with $V(R_i) = V(G)\ \forall i$. $P_C(k) = |\{c \in C|\,(c) = k\}|/|N|$ ist maintained, so

$$P_{R_i}(k) = P_G(k)\ \forall R_i \in \mathcal{R}\,. \tag{2}$$

Define

$$P_{\mathcal{R}}(Q) = \frac{|\{i \in [1\,,\,|\mathcal{R}|]\,|\,q_{R_i}(\mathcal{C}) = Q\}|}{|\mathcal{R}|}\,. \tag{3}$$

and test the hypothesis

$$H_0 : P_{\mathcal{R}}(Q = q_G(\mathcal{C})) > \epsilon\,, \tag{4}$$

against the alternative hypothesis given by $H_1 : P_{\mathcal{R}}(\cdot) \leq \epsilon$.

Community Decomposition and Quality Estimation I

Community Decomposition and Quality Estimation I

Quality Estimation

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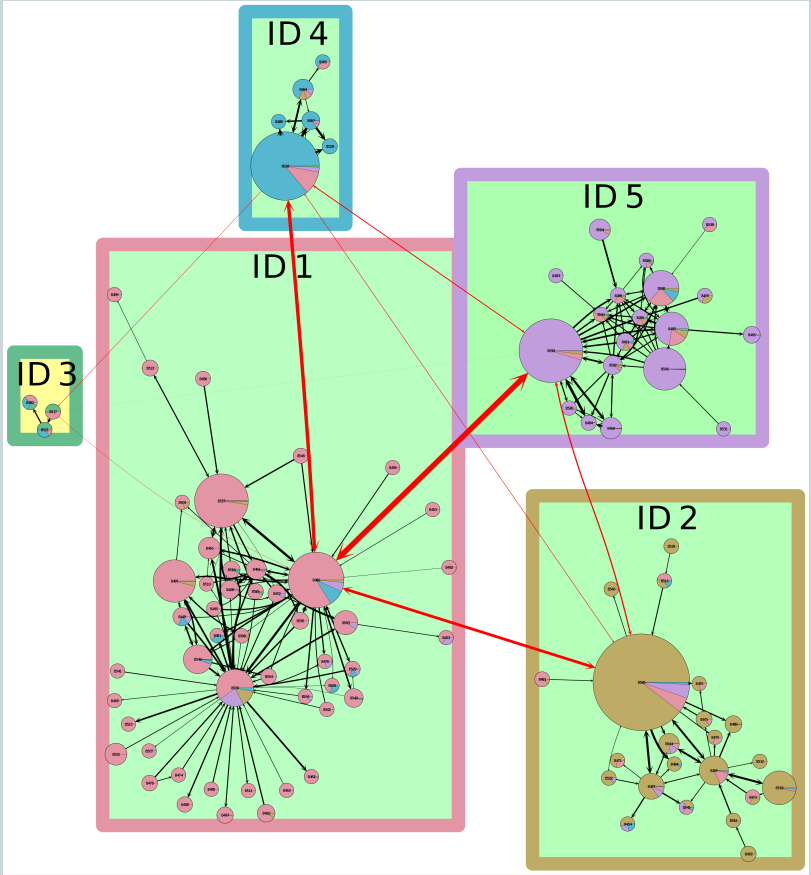
Community Decomposition and Quality Estimation III

Cheat Sheet

- Boxes: developer communities
- Background color: strength of community (green=strong, yellow=weak)
- Box border color: unique community identifier
- Pie chart: fraction of developer participation in given community color
- Node size: developers importance according to centrality measure
- Link thickness: strength of relationship between entities
- Link color: red is inter-community



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Input needed: Validate/Refute

Developer Input

- Qemu, Linux kernel, Apache httpd, Joomla, jQuery, PHP, Busybox, gcc, firefox, Perl, openssl, bootstrap, OpenStack, QT
- See you at the Codeface booth!

Image source: `greensandgills.files.wordpress.com`

Web Frontend

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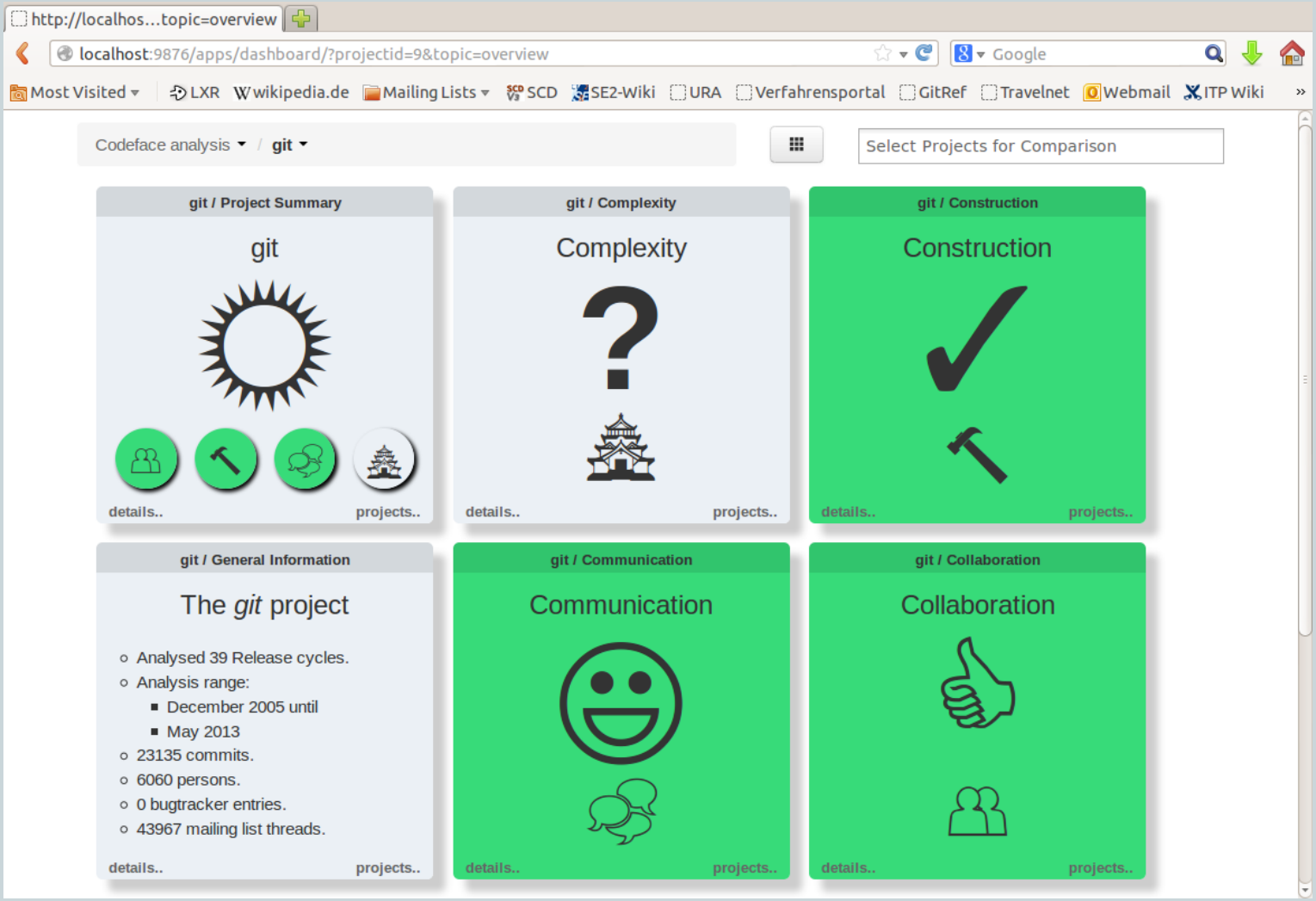
Web Frontend



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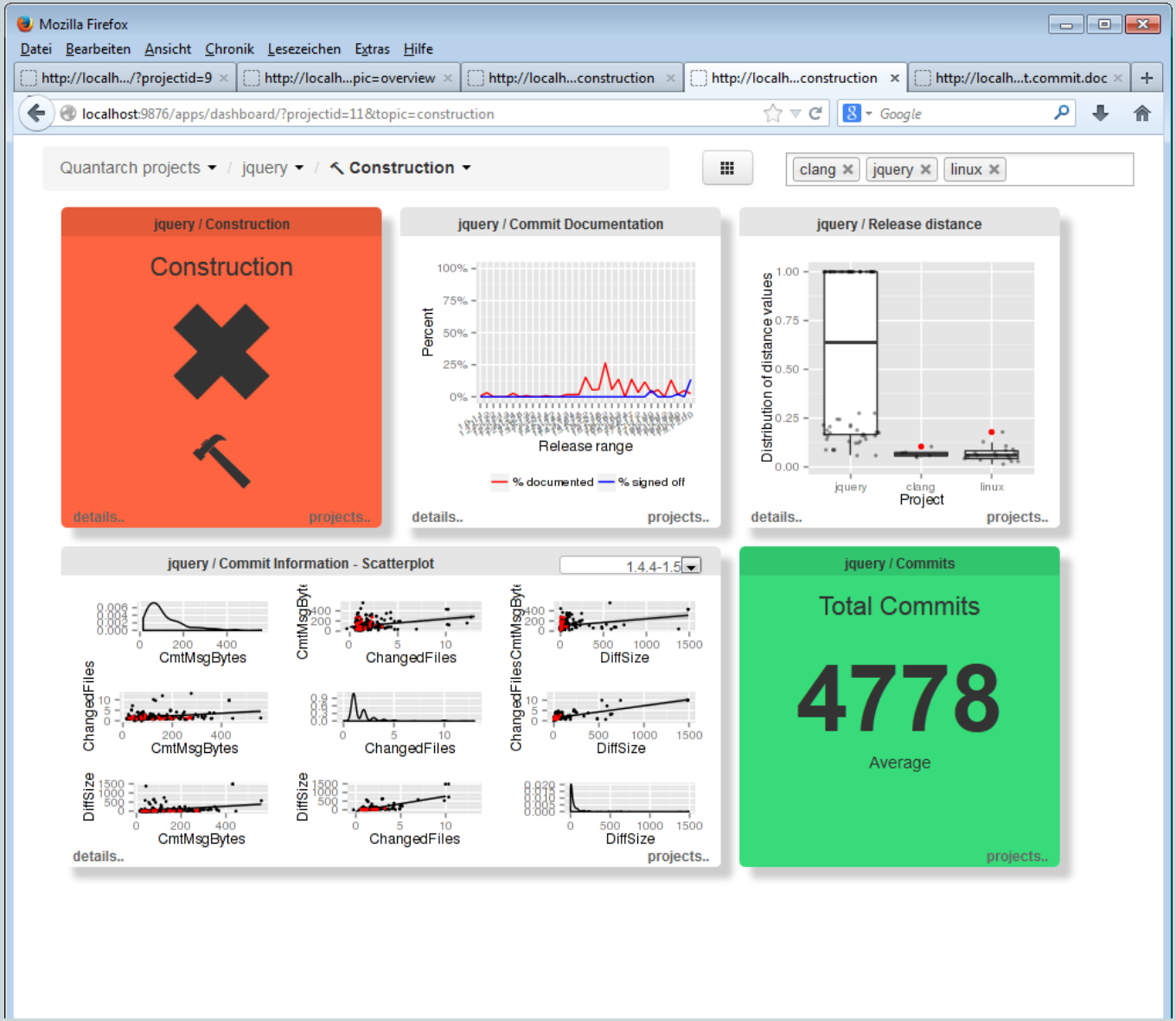

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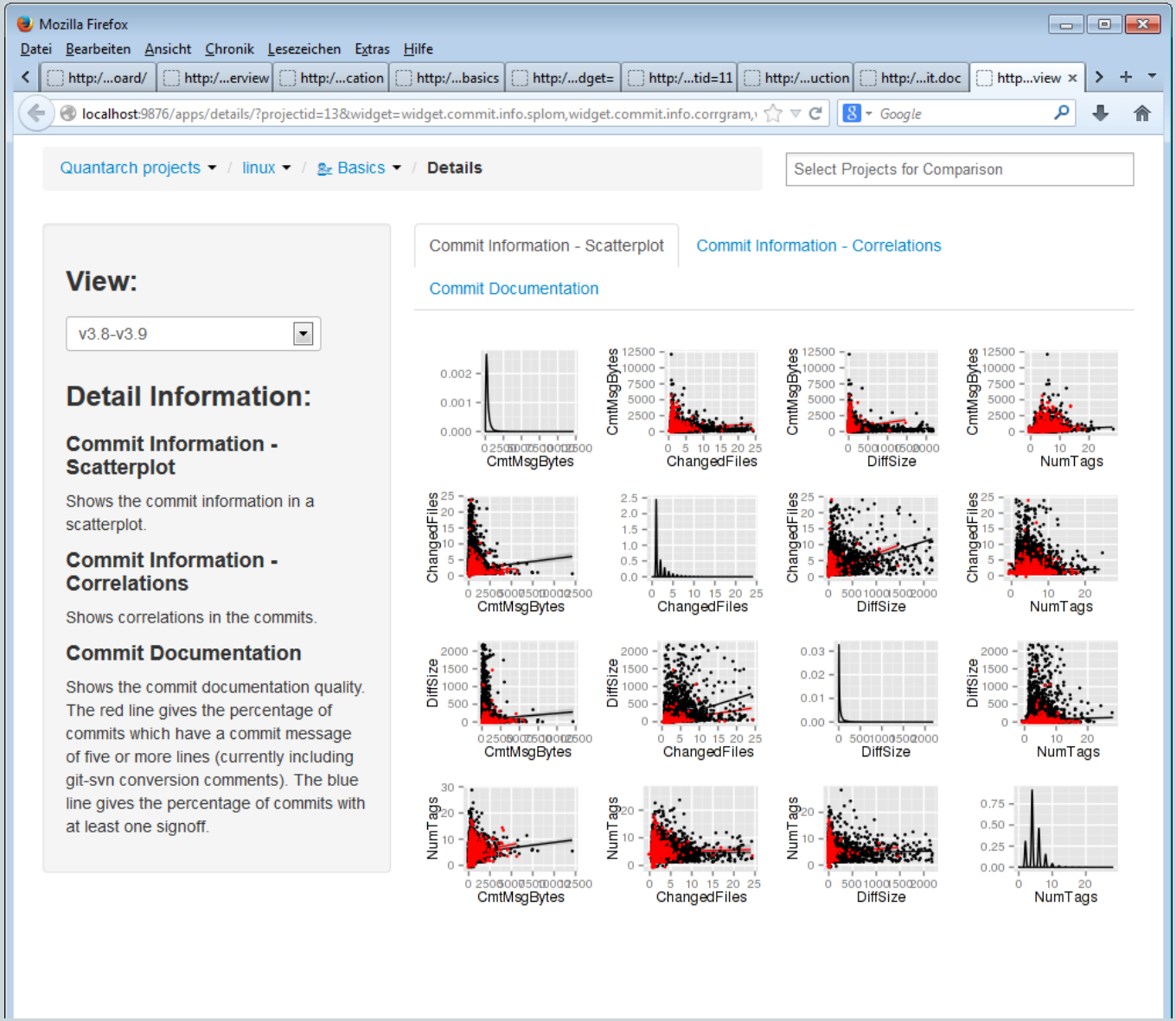

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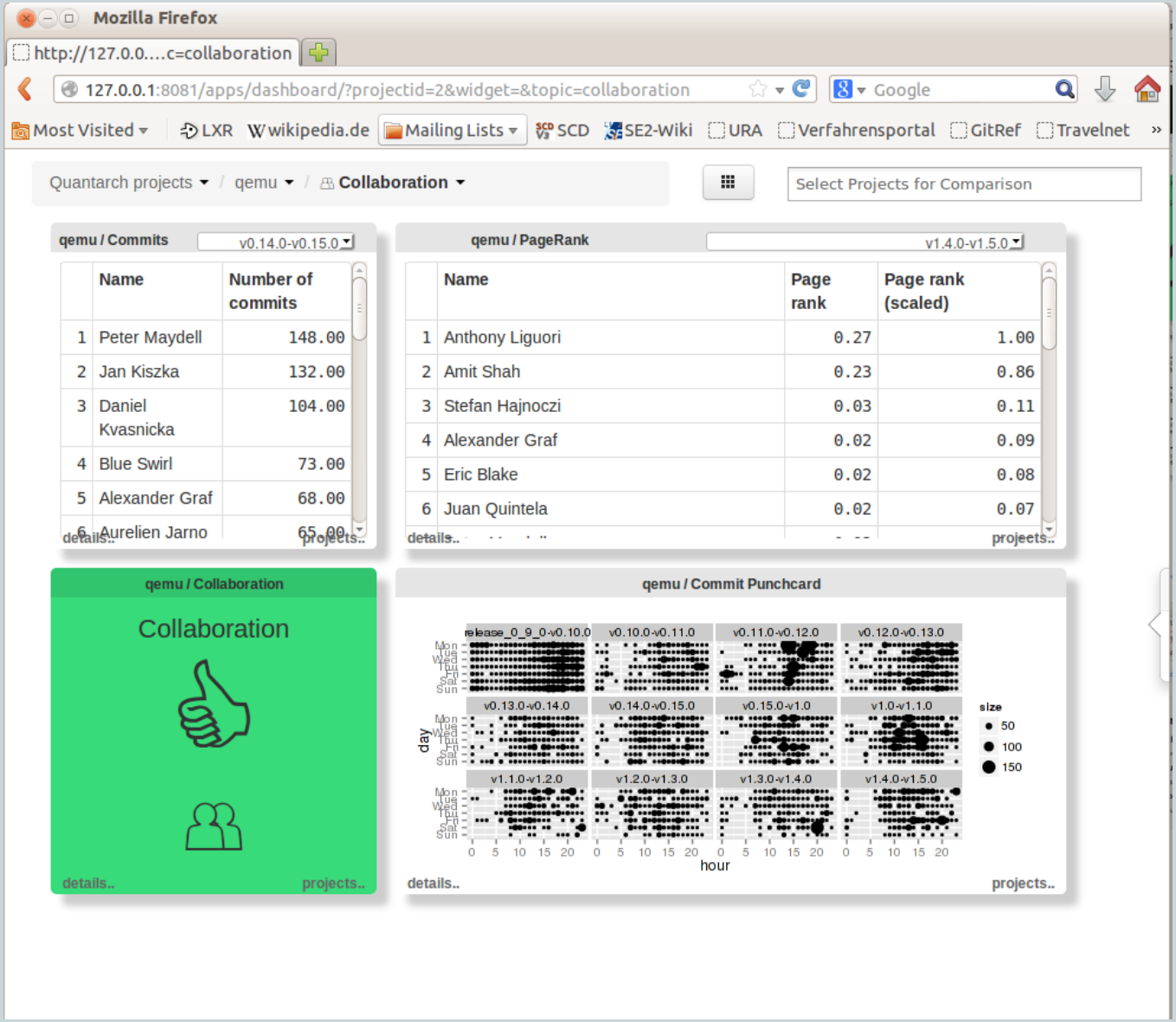

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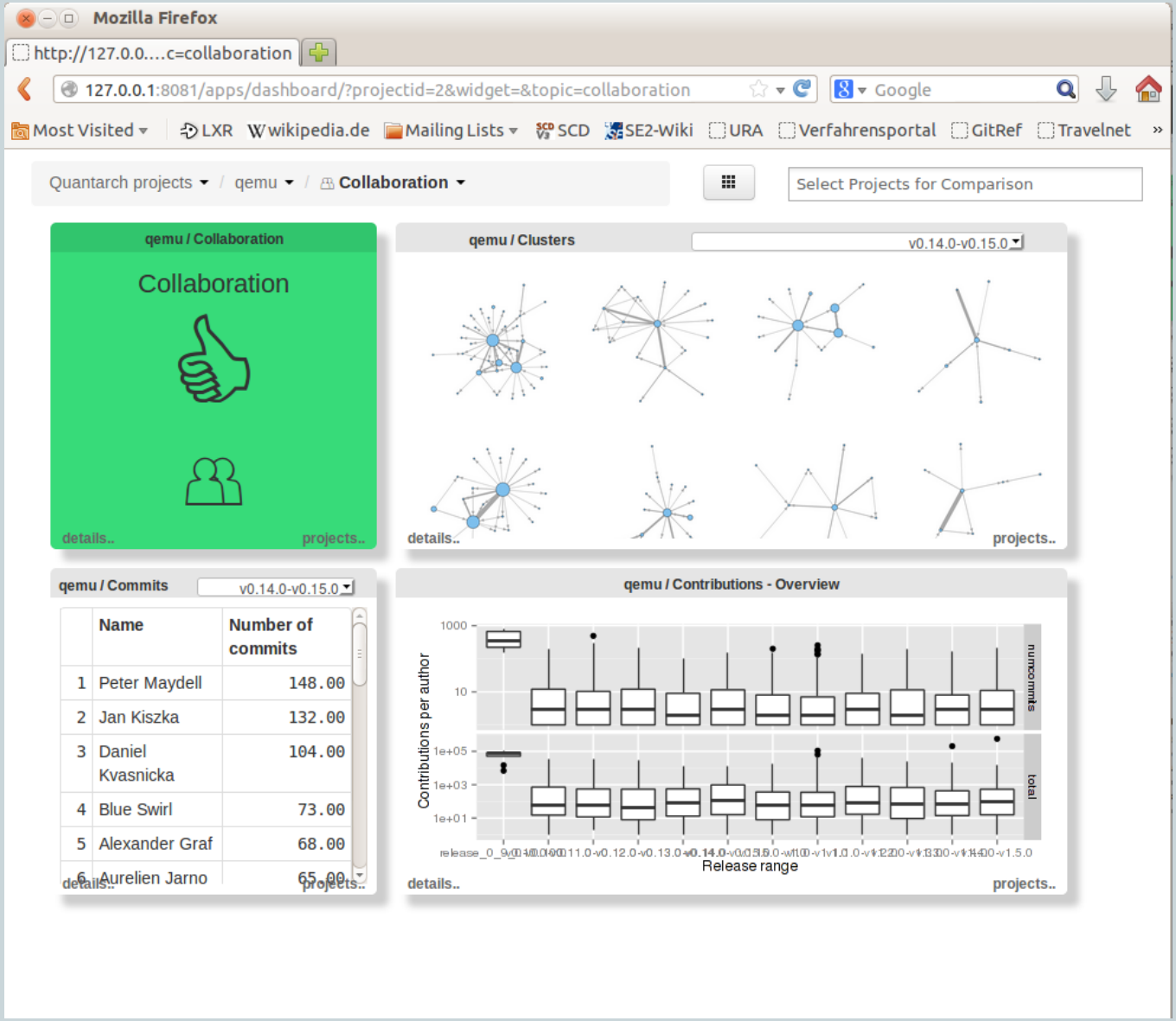


Technological Challenges

Tasks

- Parse Unstructured, real-world data
- Big data handling
- Multivariate, high-dimensional visualisation
- Statistics, Regression, machine learning
- Graph mining, clustering
- Large-scale automation
- Dynamic, reactive web frontend

Technologies

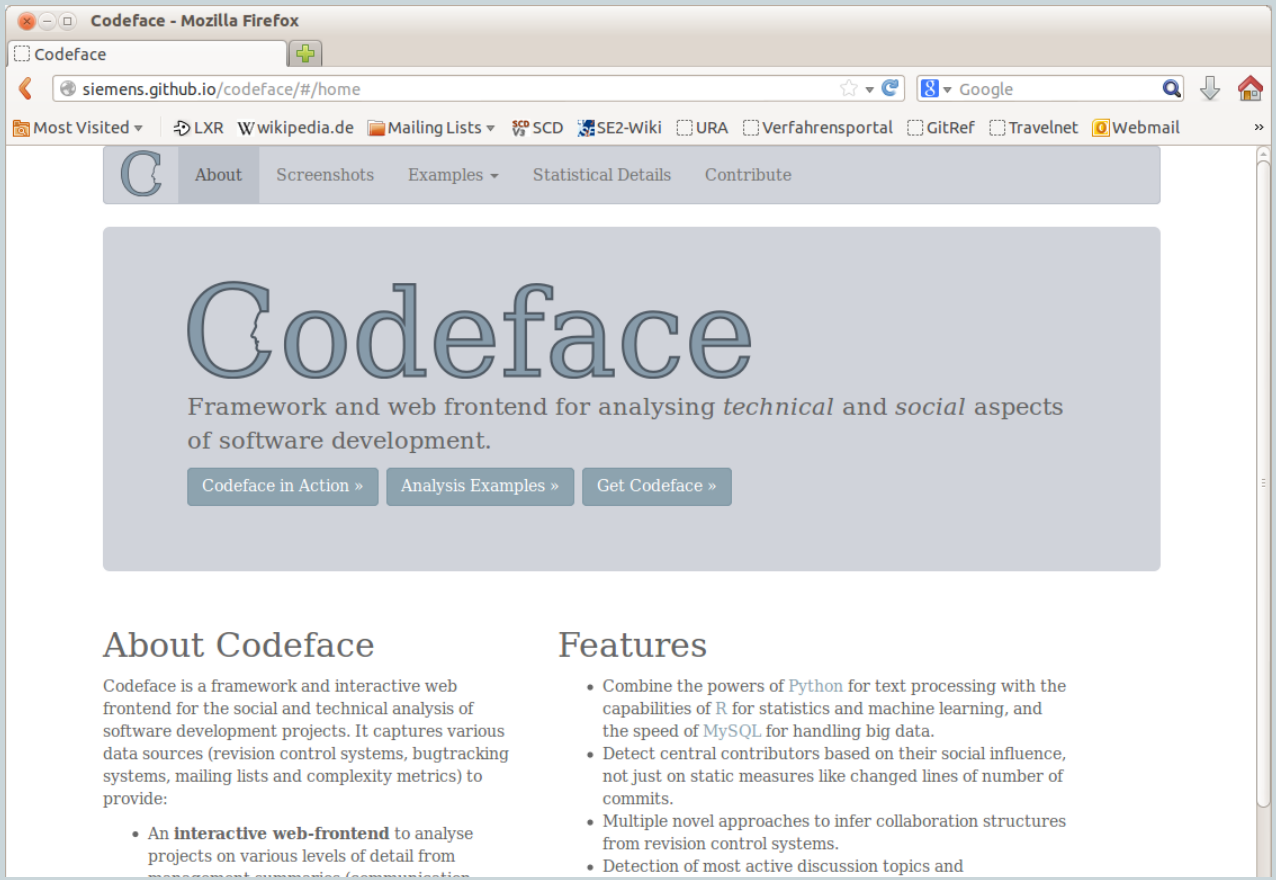
Techniques

Computer Science, Mathematics, Physics, Linguistics, Statistics

Open Source, obviously!

Online Ressources

Homepage: `siemens.github.io/codeface`
Github repo: `github.com/siemens/codeface`



Thanks for your interest!

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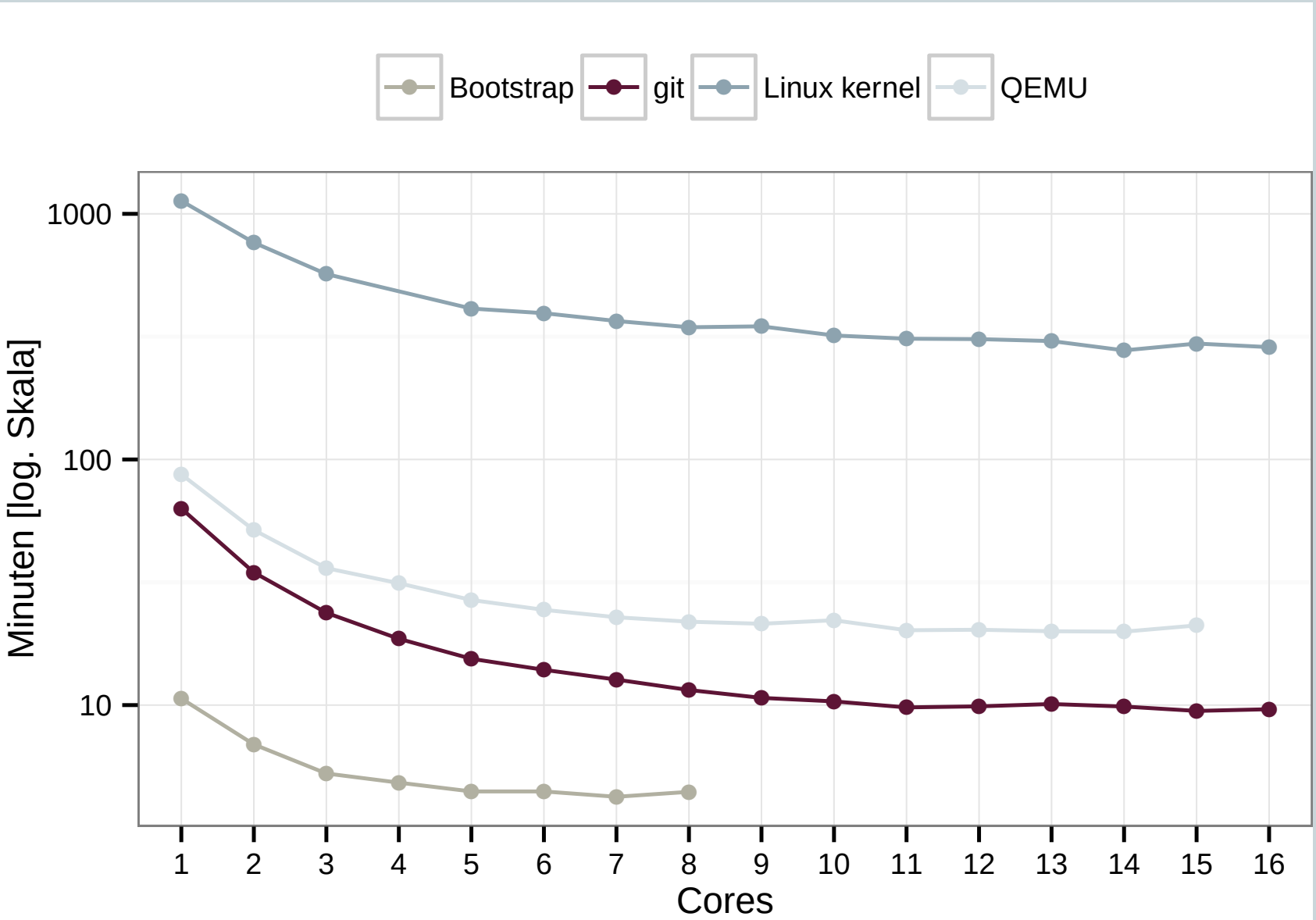
Backup: Performance Measurements



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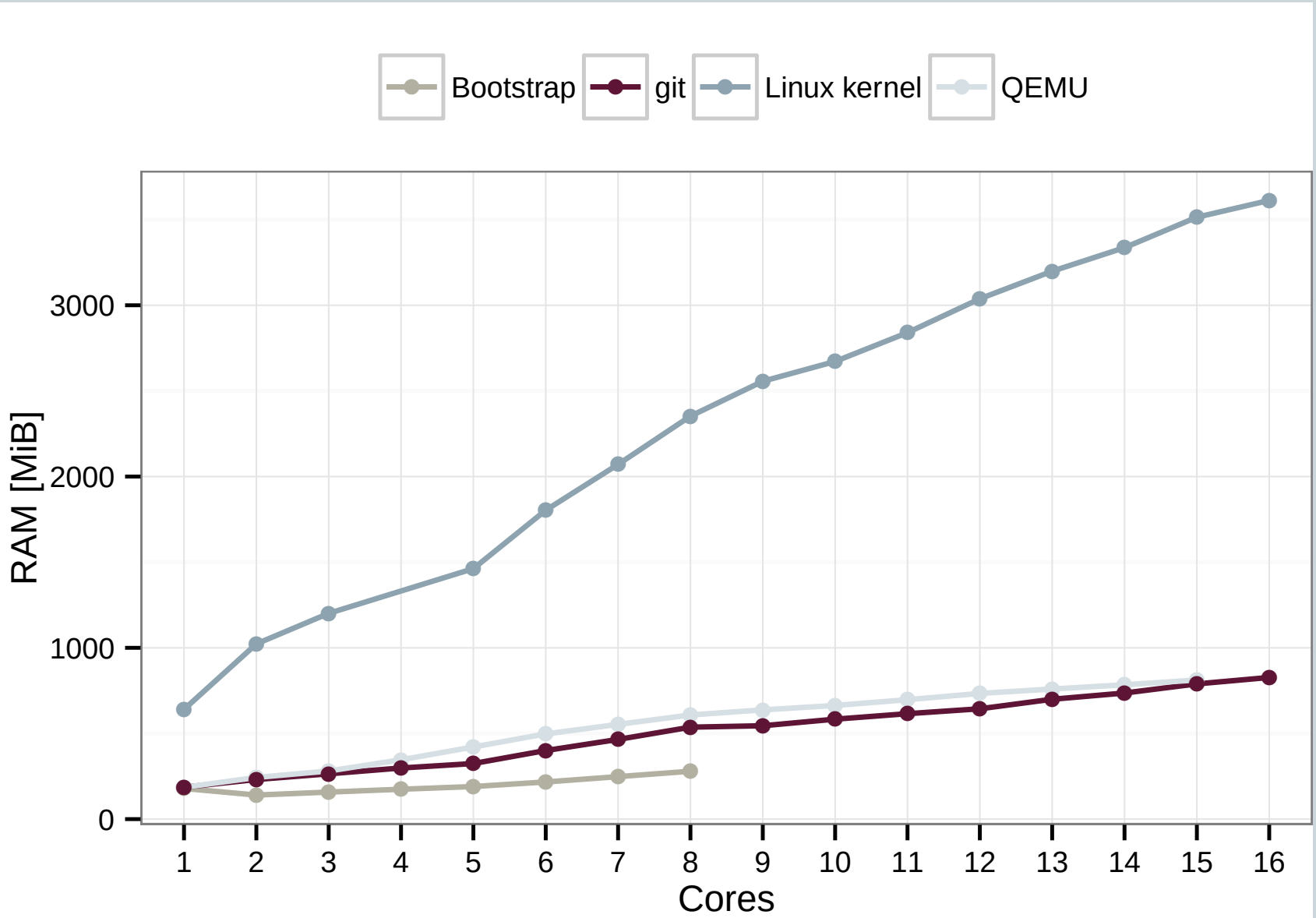

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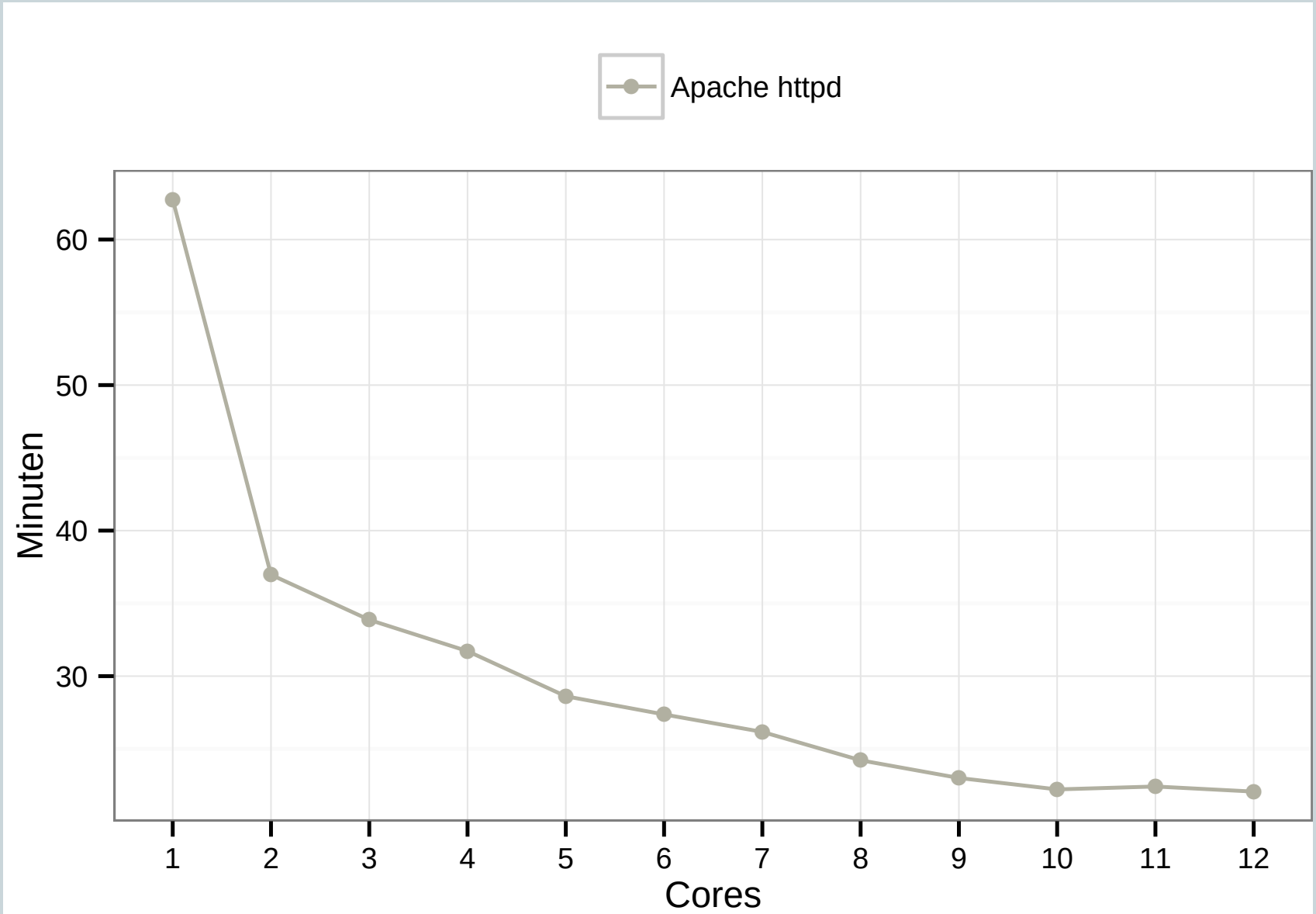

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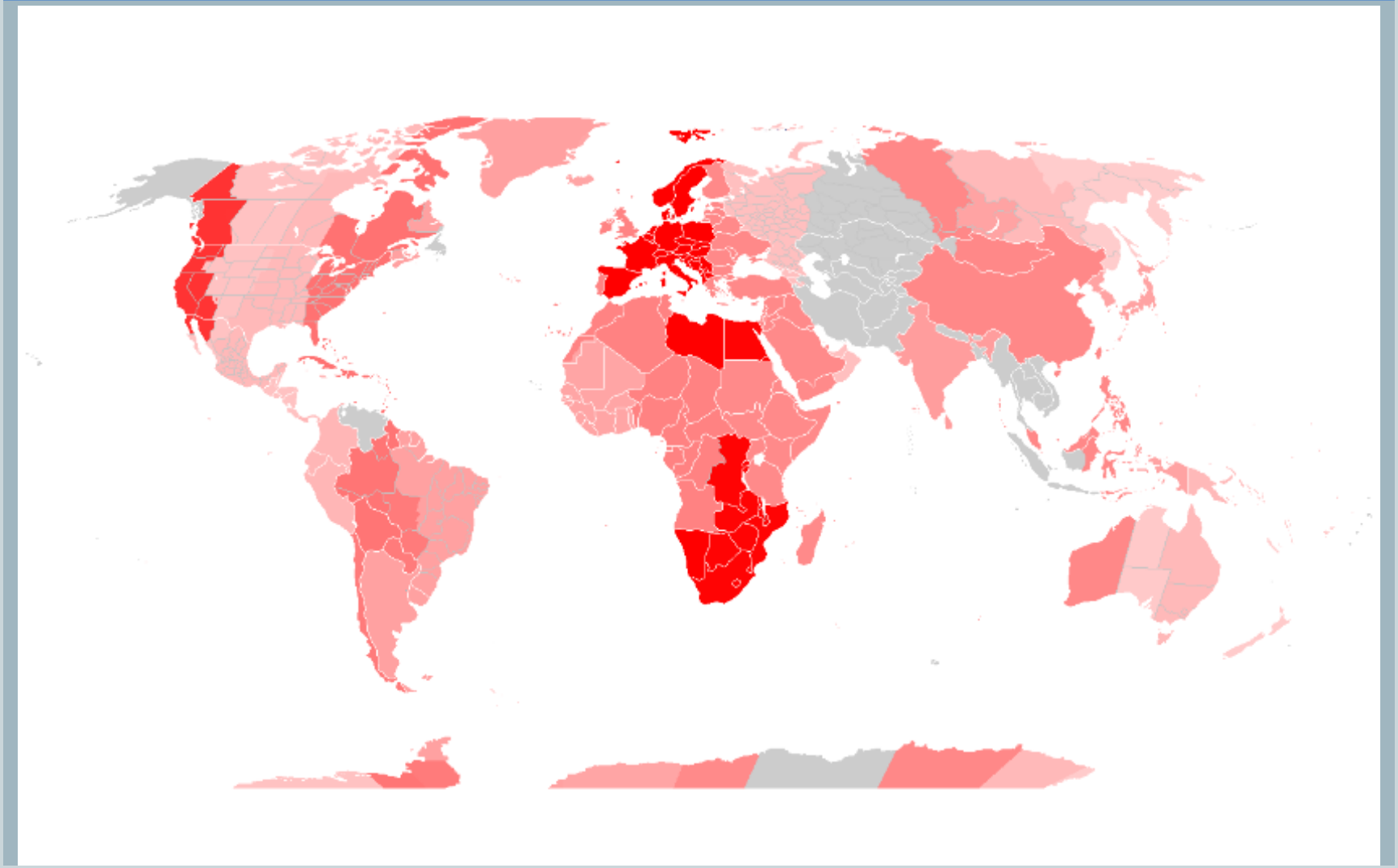
Backup: Cooperation II

Linux



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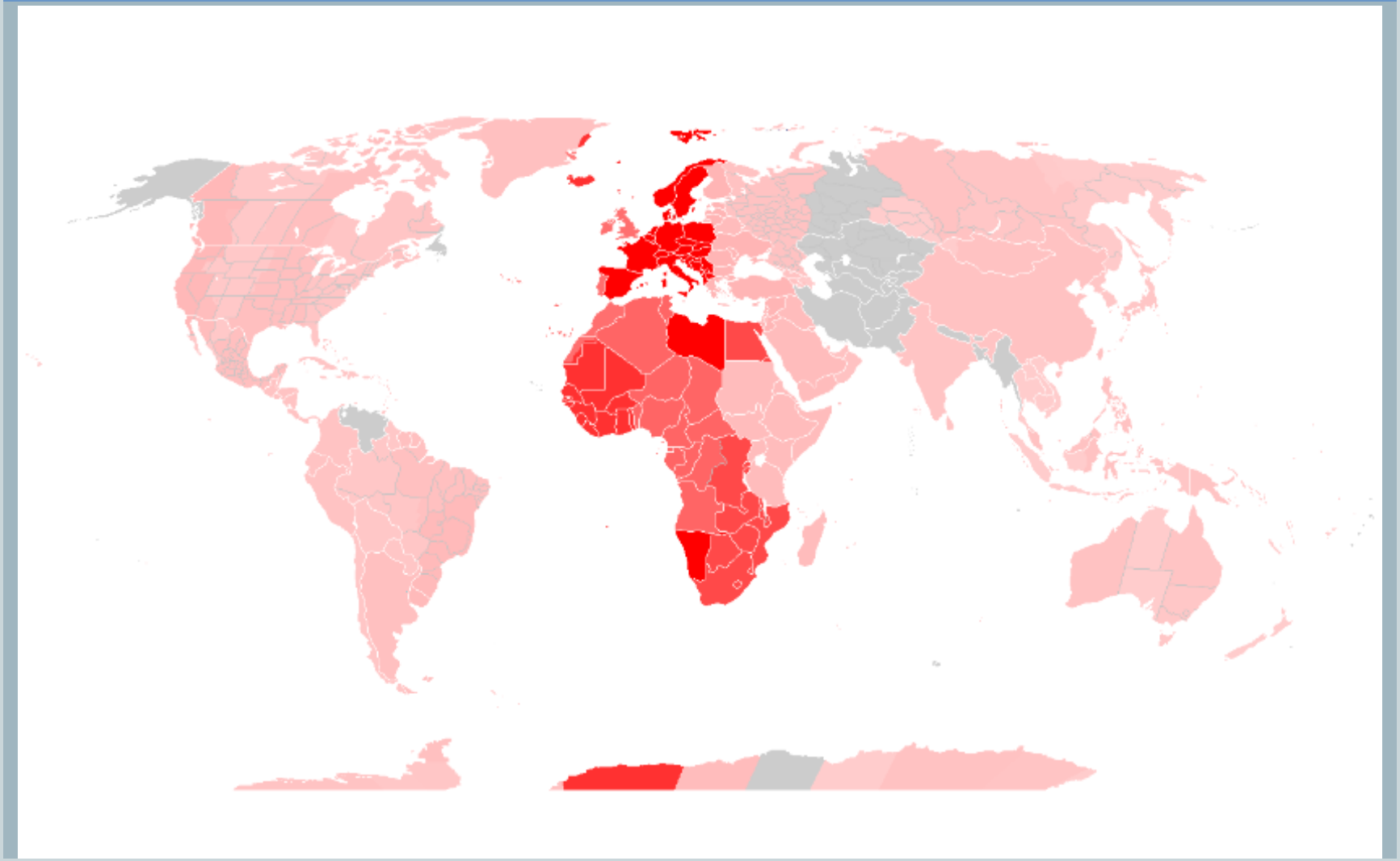
Backup: Cooperation II

QEMU



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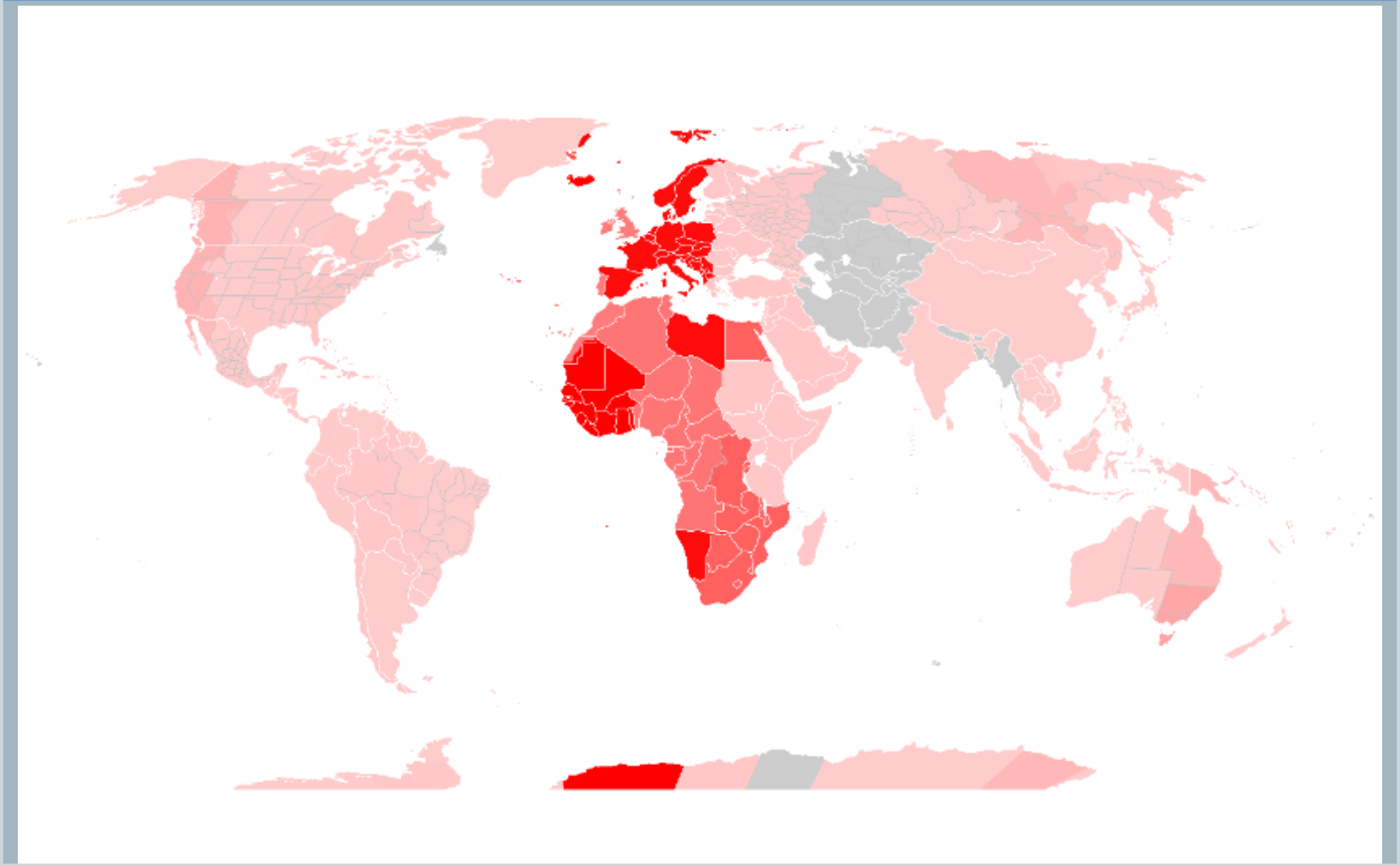
Backup: Cooperation II

Samba



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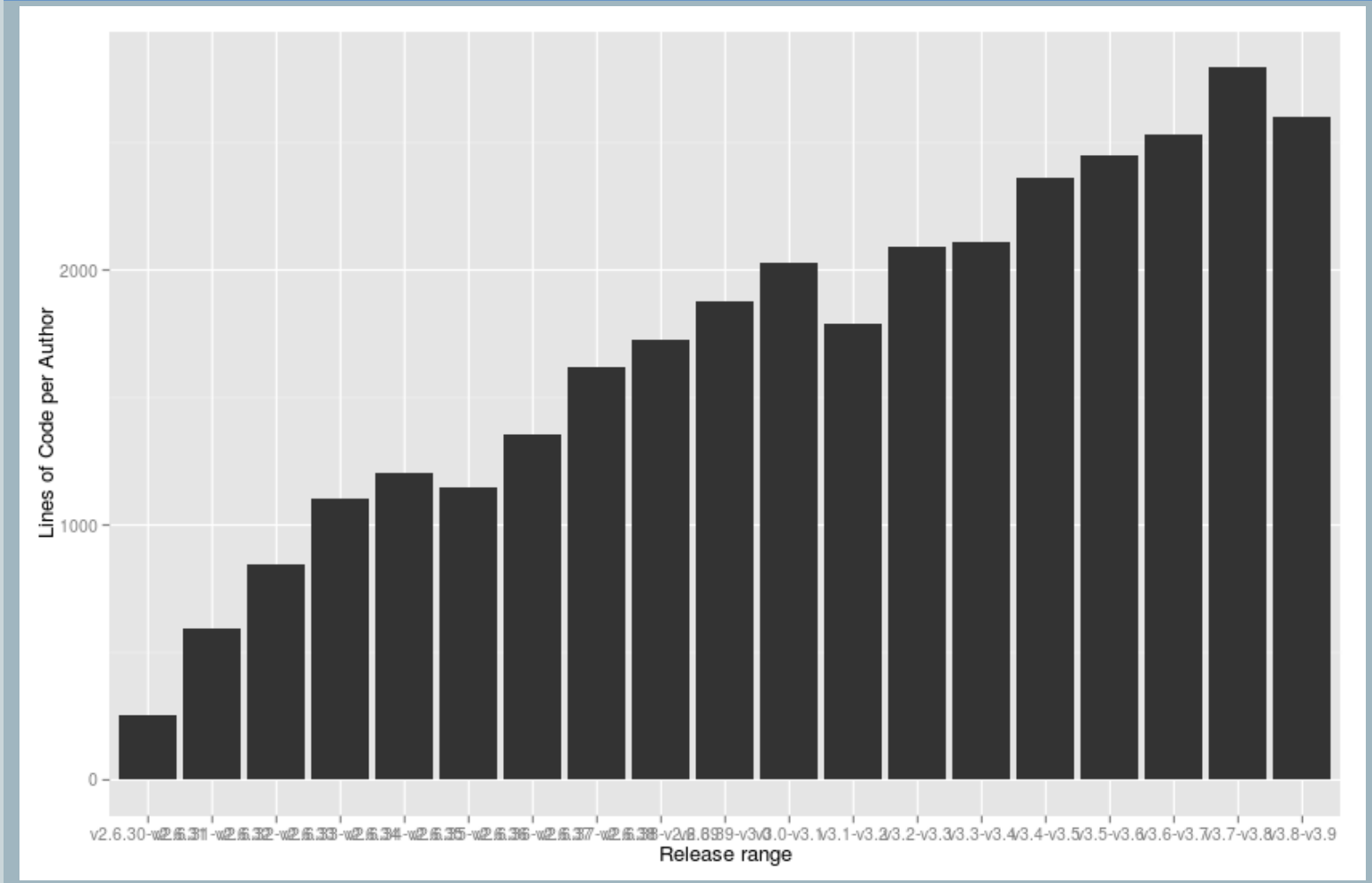
Backup: Maintainance Load

Linux



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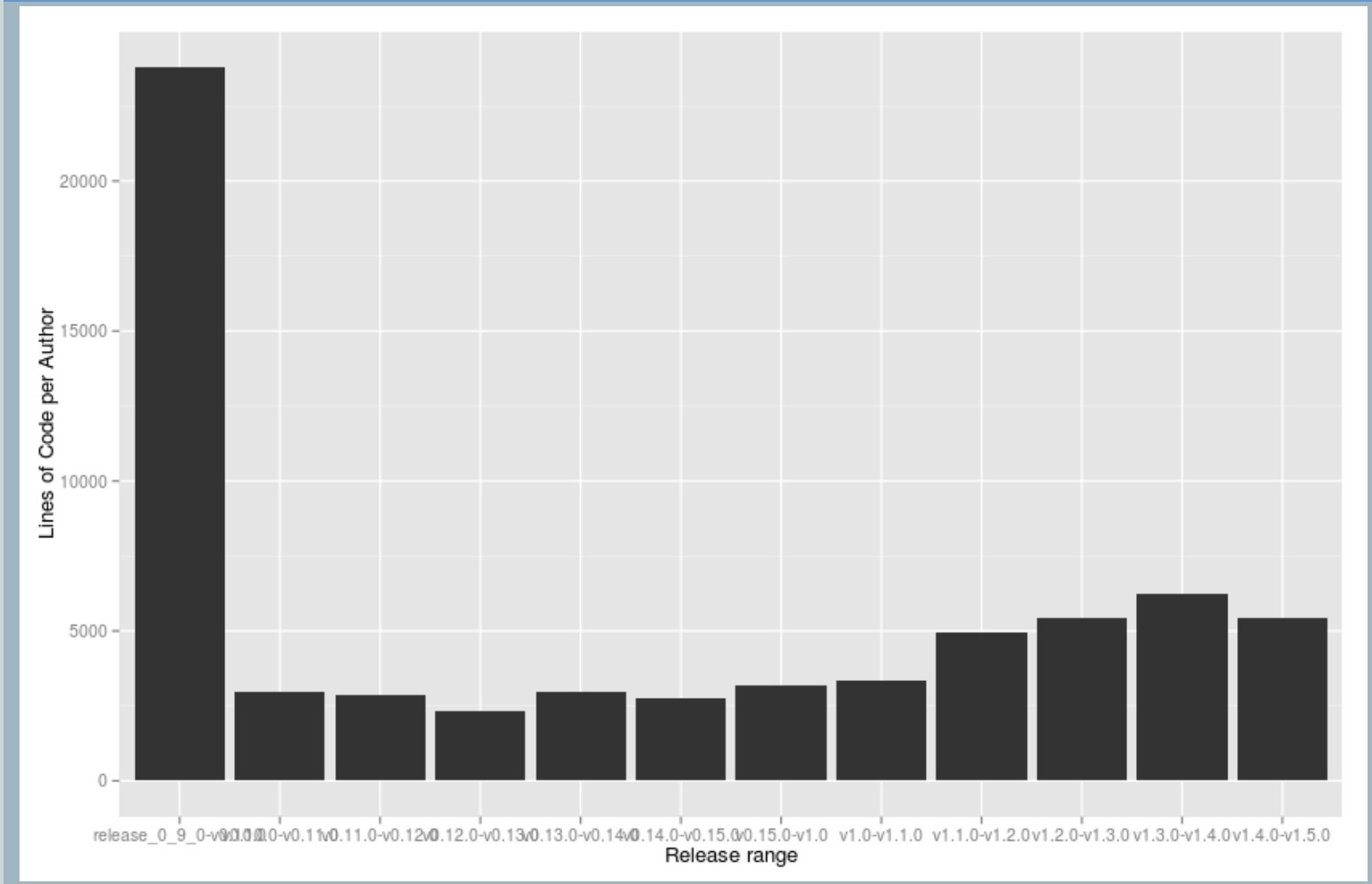
QEMU



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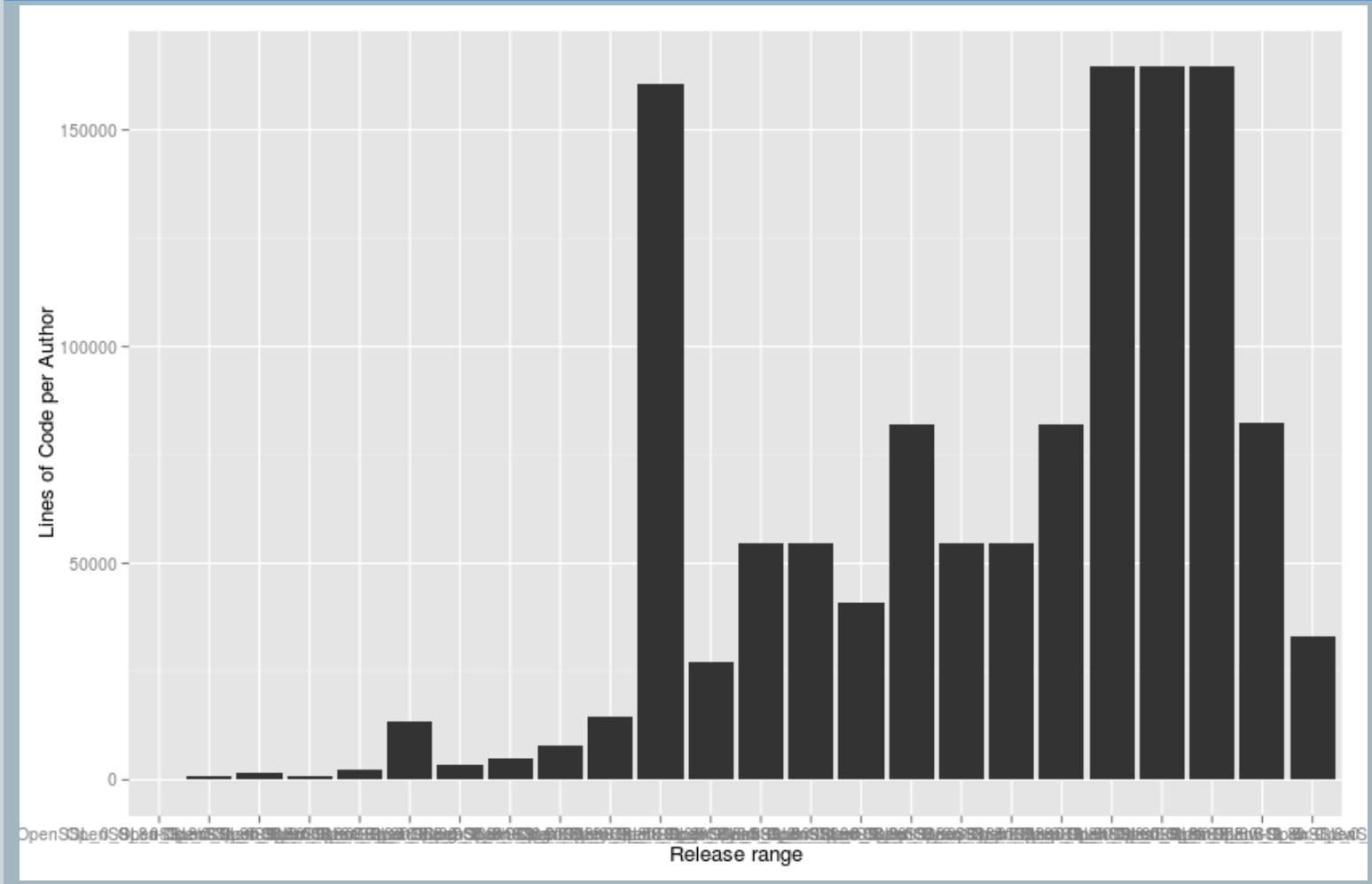
Backup: Maintainance Load

OpenSSL



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Backup: Maintainance Load

Bootstrap